THE GEOGRAPHICAL REVIEW

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THE
GEOGRAPHICAL REVIEW

VOL. XX JULY, 1930 NO. 3

FURTHER ANTARCTIC EXPLORATIONS

Captain Sir Hubert Wilkins

[With separate map, Pl. III, facing p. 388]

IN September last I set out again for the Antarctic to continue the work of the previous season.[1] With Parker D. Cramer and S. A. Cheesman, pilots, and Orval H. Porter, engineer, I left New York on the 22nd of the month on board the *Northern Prince*. At Montevideo we picked up Vigo Holt, wireless operator, and joined the N. Bugge Hektor Whaling Company's transport steamship, the *Melville*, and in company with my old friend Sverre Nielsen, manager of the Deception Island whaling station, traveled to my former base. No ice was encountered, even in the channels between the islands of the Antarctic Archipelago, and not until we reached the harbor did we see an iceberg.

ARRIVAL AT DECEPTION ISLAND

In Deception Harbor the ice this year was thin and shaky as compared with other years. When I first visited the island in December, 1919, the ice on the water was six feet thick. In 1928, when we arrived on November 11, it was less than three feet. This year it was not even two feet thick, an unexpected condition that upset our calculations and made it necessary for us to fall back on our emergency plan of operation, which was much more complicated than the one we had hoped to use.

Our machines, which had been stored without attention or watchmen throughout the winter, were found to be in good shape. The wings were under cover but the bodies of the machines had remained out in the open. They had not been snowed under. The tail surfaces

[1] Captain Sir Hubert Wilkins: The Wilkins-Hearst Antarctic Expedition, 1928–1929, *Geogr. Rev.*, Vol. 19, 1929, pp. 353–376.

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of one were partly covered with snow, which, melting in the early spring, had fractured a small part of the stabilizer. It took us but a few hours to make the slight repairs necessary and, after waiting for a spell of fine weather, to place the wings in position.

The weather was even worse than it had been the previous year. The temperature was not low—just below freezing point—but the weather was damp and windy. Last year we had prepared a runway, and it had taken us many days of back-breaking labor to carry the heavy stones from the hillside and clear a space wide and long enough for a take-off and landing. This year we had the aid of a Cletrac caterpillar tractor and an Austin Seven motor car to help us enlarge the field. Because of the peculiar weather the runway, by the time we were ready to use it, was in a very bad condition. Half of it was clear of snow but saturated with water which drained from the hillside. The other half had big snowdrifts and slushy snow upon it, and the situation was only saved by the new type large-sized tire wheels that we had brought for our planes. The field, made on the only flat stretch in the neighborhood, was of necessity narrow and could be used in one direction only. There was not an hour during the first three weeks after our arrival when conditions were favorable for flying. Yet in spite of that we were able to test the machines and although we flew many miles and covered a great deal of territory in the neighborhood of Deception we met with only slight trouble.

Beginning the Search for a Southern Base

By the time we were ready to make long flights we could see that it would be impossible to do much from Deception. The ice in the harbor had melted, and the runway was not sufficiently long for us to take off very great loads. It would be necessary to fall back on our emergency plan. This was to load plane and supplies on board the R. S. S. *William Scoresby* and seek farther south for some suitable landing field. This plan had been rendered possible by a generous arrangement on the part of the British Colonial Office and the Discovery Committee of that office whereby the *Scoresby* was made available to us on the understanding that she should carry out her scientific research as she took us from place to place. We believed that we should be able to find, somewhere along the coast or in the pack ice, a stretch of flat ice large enough to serve the purpose, and from there we hoped to make long flights and eventually to fly to Ross Sea.

After we were loaded and ready to sail bad weather held us prisoners in the harbor for two days. On December 12 we started south. The first night we reached Melchior Island, in Schollaert Channel, an anchorage used by the whalers' floating factories. The next night

FIG. 1

FIG. 2

FIG. 3

FIGS. 1 to 3—Preparations for the season's work at Deception Island. The planes after wintering in the open (Fig. 1); the Austin Seven motor car (Fig. 2); and the Cletrac tractor (Fig. 3) used in clearing the runway.

FIG. 4

FIG. 5

FIG. 6

FIGS. 4 and 5—Entrance to Melchior Harbor at the northwestern entrance to Schollaert Channel between Brabant and Antwerp islands. Iceberg in foreground.

FIG. 6—Cliff on the eastern side of Melchior Harbor viewed from the anchorage.

FIG. 7

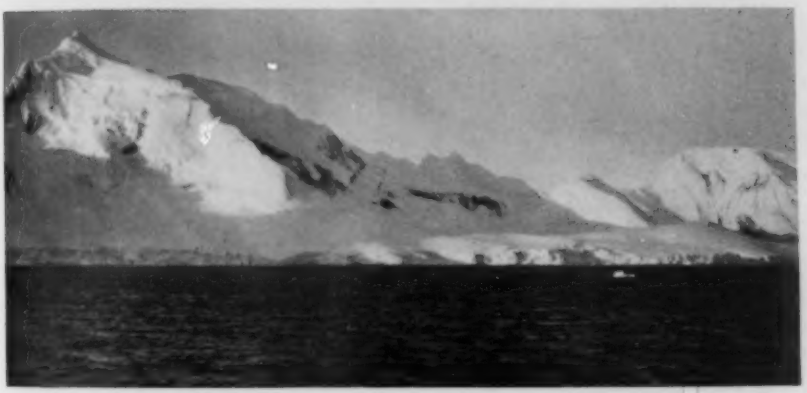


FIG. 8

FIG. 9

FIG. 7—Stratified snow at the entrance to Melchior Harbor.
FIG. 8—The southern end of Neumayer Channel between Antwerp and Wiencke islands.
FIG. 9—The Argentine Islands, in the foreground, and Beascochea Bay.

found us at Port Lockroy on the western side of Wiencke Island. Charcot on his first expedition described Port Lockroy as "the best shelter we have found in the Antarctic." It is indeed sheltered from the heavy seas, but the glacier face, sloping steeply down the mountain sides, keeps breaking off into the sea with an almost continuous roar;

FIG. 10—Entrance to Neumayer Channel.

and, while the falling pieces were not large enough to endanger our vessel, the harbor was so full of broken ice that it was quite unsuitable for a seaplane take-off. On the way we had passed through the spectacular Neumayer Channel. Mountains reaching to ten thousand feet rise almost sheer from the water. About their sharp peaks is an almost constant whirl of snow. Halfway up their sides the massive cliffs are so steep that snow cannot cling to the surface, and these cliff faces are stained a variety of colors. One place, where the stains are vividly green, has been named Copper Mountain; but no one has so far been able to reach the precipice or investigate its content.

From Port Lockroy we put out through Bismarck Strait into the wide Pacific Ocean. So far we had seen very few icebergs and practically no pack. The ice was extremely far south this season. We met the first pack, much broken and mushy, off the Biscoe Islands. Pushing southward as far as the southwestern end of Adelaide Island we came to a bight which seemingly gave near approach to the land. We were, however, held up long before we reached the land-fast ice. Although we followed the edge of the pack for miles we did not see a single floe of sufficient size for even an emergency landing and nothing half big enough for a take-off with skis. All the ice surface was rough

and much broken, a condition that made it impossible even to land the machines from the deck. It was a great disappointment. I had seen many floes suitable for a landing field in this neighborhood in other years, but this year they did not exist. Nor could we take off from the water: the sea was either too rough or the swell too great even to

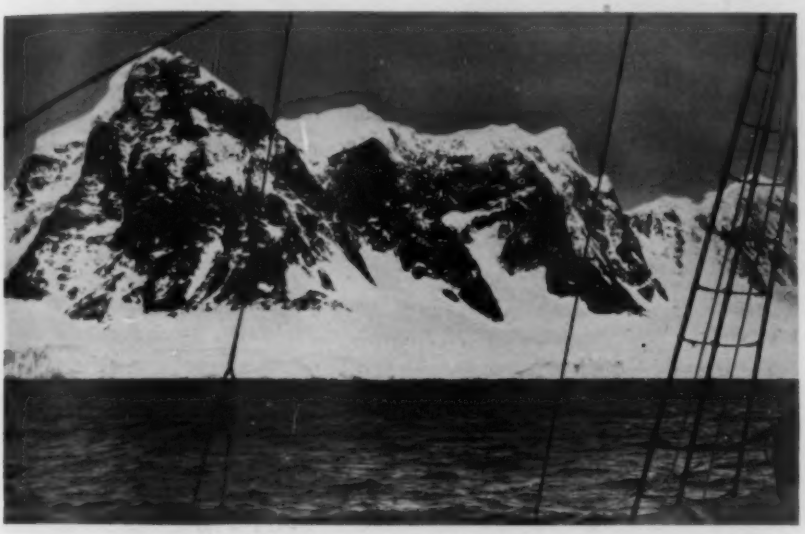


FIG. 11—Neumayer Channel.

launch the plane; and, after waiting almost a week, there seemed to be only one thing to do, and that was to return to the ice-free Neumayer Channel.

On the way back we made an attempt to push into Grandidier Channel, where there would almost certainly be smooth ice. At the head of the channel hundreds of bergs were stranded; and between them and extending for many miles was a floating mass of heavy pack—far too thick for any vessel to penetrate. The charts of this region are unmarked with soundings, and the ground was known to be foul with submarine pinnacle rocks rising sheer a hundred feet or more. As we were going slowly forward one day our anchor, hanging twenty fathoms beneath the bow, caught fast on a rock—when there was no bottom at a hundred fathoms at the stern of the ship a hundred and fifty feet away! We pushed and shoved at the ice in Grandidier Channel for several hours without making much headway towards the smooth ice which we could see from the masthead. Nor was it possible to fly our supplies to the flat ice, for the sea outside the pack was too rough. Even well inside the ice edge the swell was great. Reluctantly we continued on to Port Lockroy which we reached on December 18.

Flight from Neumayer Channel to Weddell Sea

On the day after our arrival the weather was fine, and we soon had the seaplane overboard and ready for flight. I had planned to cross the southern of the two main islands of the Antarctic Archipelago and, by covering its width in longitude, determine the accuracy of last year's mapping of the east coast. The mountains in the vicinity of Port Lockroy are high. Farther to the east, over the shelf ice in Weddell Sea, we had flown last year at 8000 feet and then had seemed to be well beneath the level of their peaks. This year, when over Flanders Bay, as we came level with the mountain tops, our altimeter registered 9000 feet. Even at this altitude we could not clear them with safety, so we flew over the valleys between. Finally we climbed to 10,000 feet for safety, only to find ourselves in the influence of a strong east wind. We could look across the col at the head of Flanders Bay into Evans Inlet, discovered last year, and see that the distance across was short. To avoid the wind we descended to 9000 feet. Our engine was not functioning perfectly; so, for safety in case a landing was necessary, I decided to follow the western side of the coast as far as Beascochea Bay and then, if the engine had recovered, turn toward Weddell Sea. Close beside the mountains we flew. We passed Mt. Peary, one of the noblest peaks in that vicinity, and covered Wandel Island, where Charcot had wintered in the *Français* (1904), and Petermann Island, where he had wintered in the *Pourquoi Pas?* (1909). The channel between these islands was comparatively clear of ice. In Leroux Bay and Grandidier Channel the ice was fast and unbroken as far as we could see.

Mt. Chevreux, opposite Leroux Bay, is high, well over 9000 feet. Flying between Mt. Chevreux and Mt. Perchot we crossed the narrow neck of land between Leroux Bay and Richthofen Valley. A first glance in the direction of Weddell Sea was mystifying. It looked as if a plateau extended eastward as far as the eye could see. According to my last season's calculations the land should have been not more than twenty-five miles wide at that point. We were flying at an air speed of one hundred and twenty-five miles an hour, and we had been going for ten minutes. We should have crossed the land in that time, unless of course our air speed did not correspond with our forward speed. An observation for ground speed and drift showed our forward speed to be less than sixty miles an hour. We had a sixty-mile-an-hour head wind. And now I could see that what had appeared to be an endless plateau was in reality a mass of soft white-topped cloud. As a matter of fact we soon crossed the highland and proved that our calculations made last year were correct. It is about twenty-five miles from Leroux Bay to Richthofen Valley, and between Flanders Bay and Evans Inlet the distance is shorter.

Below us we could see hazily through the edge of the cloud the

FIG. 12

FIG. 13

FIG. 12—The *William Scoresby* and the seaplane *Los Angeles* at Port Lockroy.
FIG. 13—Port Lockroy on the western side of Wiencke Island.

steep slopes dropping down into Richthofen Valley. Last year I had named the capes on either side Cape Fritsche and Cape McCarroll. We flew onward almost to Cape Fritsche. In the distance, to the northeast, we could see Robertson Island. The clouds were lower there. Southwest of us the Foyn Coast, which could be traced by the fringe of cloud, turned southwest until it swung almost due west to form Crane Channel. Jason, Veier, and Foyn islands were lost beneath the clouds. I very much wanted to follow Foyn Coast and trace Crane Channel accurately; but our fuel was not sufficient, and I hoped some time later to do that work. The chance, however, did not occur, and we cannot say definitely that this channel runs right through at sea level from the Weddell Sea; for as we flew, Mt. Napier Birks obscured the shores from sight. Later, far out at sea from the deck of the *Scoresby*, we had an opportunity to study with high power binoculars the topography thereabouts, and I still believe that Crane Channel exists. It is not a clear water channel but is filled with ice, probably shelf ice in part.

The head wind had been so strong and such a hindrance that from near Cape Fritsche we turned back and with the gale on our tail were soon over Beascochea Bay. The great cirque at the head of the bay is the most awesome thing I have seen from the air. I had directed Cheesman to fly over it, and with ready obedience and skill he did so. But he opened the engine throttle wide. It was no place over which to linger. Whirling currents caught the machine. We looked down into what seemed to be a cylinder leading down to hell. The whirl of the wind had scored its snowy sides in corrugations; dust and rock fragments torn from the cliffs near by made it look bottomless; and the drop was almost sheer, we believe, for about 6000 feet. From Beascochea Bay we swung out and over the Argentine Islands to verify their position and that of three new islands that had been added to the chart from the deck of the *Scoresby* when we had been in that vicinity the day before. The Argentine Islands are far from correctly placed on the Admiralty chart. Considerable geographical work was done in the vicinity by the *Scoresby*.

In Beascochea Bay we had seen low flat ice extending for fifteen miles, apparently a perfect surface for a take-off. Bordering the edge of the ice there was a stretch of open water, but in order to reach it we should have to push the ship through several miles of thick pack. We flew back with light hearts to Neumayer Channel.

Attempt at Long Flight from Beascochea Bay Ice

We lost no time in getting the machine on board the *Scoresby*, and we were soon (Dec. 19) under way for Beascochea Bay. Rounding the Argentine Islands we turned toward the land. The pack ice

FIG. 14

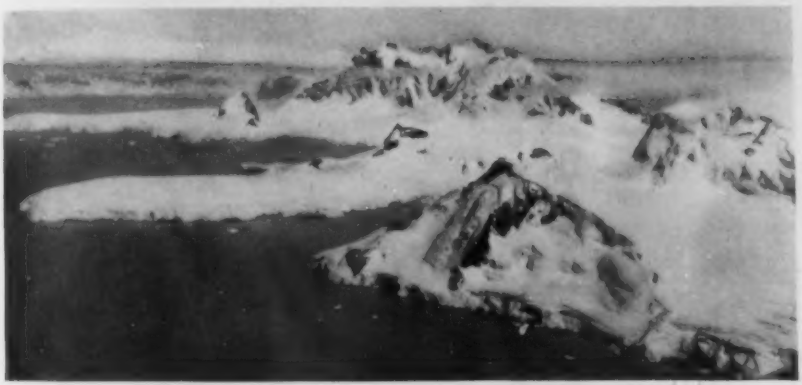


FIG. 15

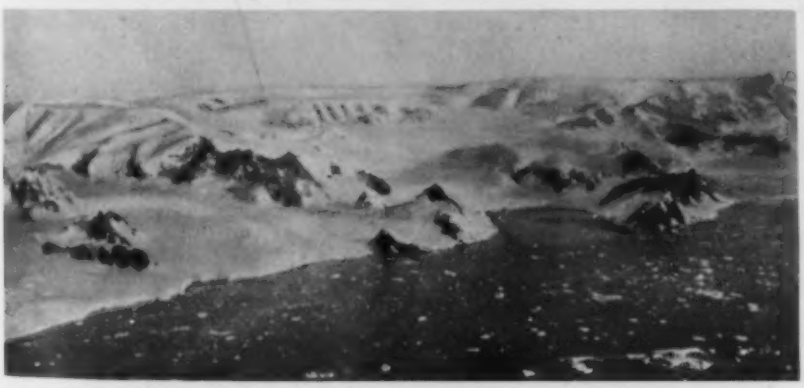


FIG. 16

FIG. 14—Port Circumcision, Petermann Island, winter quarters of Charcot's expedition, 1909.
FIG. 15—Mt. Peary, an outstanding summit of the Graham Coast.
FIG. 16—The coast south of Mt. Peary.

became thicker and thicker. It was less dense near the islands, but we dared not go too close for fear of running aground. From the air we had seen many rocks awash, and the water was known to be treacherous. After pushing for twelve hours through the pack with slow progress we came to the open water and approached the ice shelf. It was very low. The top of the ice was not more than six

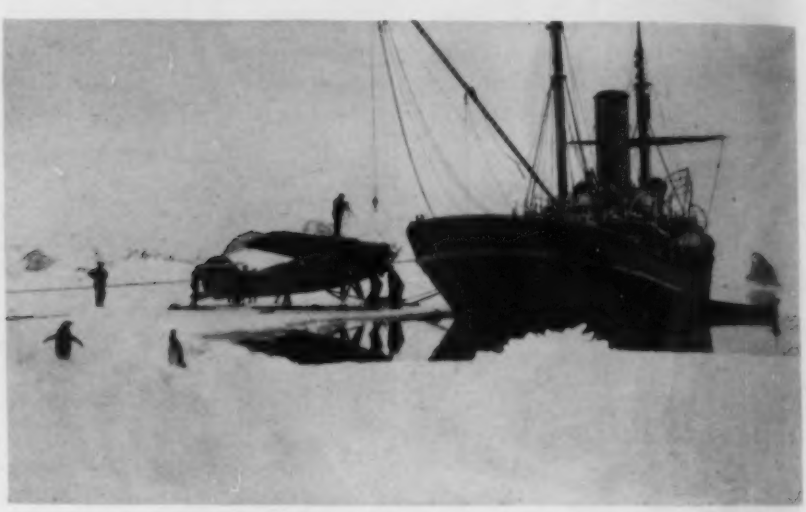


FIG. 17—On the ice at Beascochea Bay: the seaplane ready to be reloaded.

inches above the water. This was a disappointment. From the air it was not possible to judge the thickness of the ice but we had hoped it would be several feet. As the *Scoresby* came alongside we eagerly jumped to the ice. It seemed firm and solid even under tests with ice picks and chisels. We had arrived at the ice at midnight. By breakfast time we had the machine overboard and then unloaded the motor car which we had brought along to test the way and carry our supplies from the ship to the point of starting. As we worked, many Adélie penguins gathered around and watched us, full of curiosity about our movements.

By lunch time all requirements for the long flight were ready to be transferred to the head of the bay. We started out with the light car to pilot the way. Suddenly down it went through the ice into the water, fortunately to be held up by another layer of ice beneath. The car was only a tenth as heavy as the airplane; but, everywhere we tried it, it went through the crust of ice. It was astonishing. The temperature had been low when we started; we had been intensely busy, and the increased warmth felt we attributed to the unaccustomed exercise. An examination of the thermometer showed that the air temperature had risen from 24° F. at midnight to 54° F. at noon! The

sea water had also changed from 32° to 37°, a most surprising rise in so short a time and a most unusually high temperature for that part of the world, where during the summer the temperature is generally just about freezing point. The warmth continued throughout the day. Our airplane on skis began to sink into the ice, and we had to make haste and get it back on board the *Scoresby*. Obviously it was

FIG. 18—Looking down Grandidier Channel from opposite Beascochea Bay.

not worth while waiting for colder weather. The season was advancing rapidly, and as a result of the melting the surface would be so uneven and full of water holes that it would make a take-off from there not merely dangerous but quite impossible.

We reloaded and felt our way around the edge of the pack and out to sea, passing hundreds of small icebergs stranded in the vicinity of the Argentine Islands. The sight, as we threaded our way among them by the light of the midnight sun, was as beautiful and wonderful as any I have seen. All colors of the spectrum radiated from the crystal sides of the stranded bergs. The sun's rays scintillating at a low angle tinged the mountains near by as well as the ice with a reddish golden hue. Slowly ahead we went with the anchor down. Every now and then we would run into rocks and shallow water. It was a thrilling night; we did not leave the bridge.

SOUTHWEST TO FOLLOW THE PACK ICE

Our best chance now seemed to be in pushing farther south and west in the hope of reaching the land-fast ice or some flat floe in the pack from which to fly to shore, or some smooth water from which to

launch our seaplane. Free of the ice we headed south, a storm with us. Once more we were abreast of the southwestern end of Adelaide Island. The edge of the pack in this vicinity was still far from land. We followed it closely, hoping that somewhere north of Charcot Land we might find ourselves near the solid land-fast ice. The weather turned fine again, but a constant swell made seaplane flights impossible. The pack between longitudes 70° and 73° W. edged along latitude 67° and then took a turn directly southwest until it reached latitude 68°, whence it trended due west. At longitude 75° the edge turned abruptly south but only to form a narrow bight: we had proceeded less than thirty miles in a southerly direction when we came once more to the thick pack. By this time we had used almost half the fuel oil for the *Scoresby* and could not afford to make any farther westing. It was decided to wait in the pack for a few days at least or until it was calm enough to make a flight. On Christmas Day we were about twelve miles south of latitude 68°. There was a high wind blowing, and dark clouds hung low in the sky. The swell of the sea had risen until the wave crests were twenty feet or more in height. The grinding of the ice floes made doleful noises, and our prospects did not look hopeful. With the easterly wind the pack drifted farther and farther north.

By the morning of the 27th we had drifted near a tremendous iceberg. But big as it was it offered little shelter. The high wind swept along its flat-topped surface and sank to the sea again almost at the edge of the ice cliff. The swell of the ocean curled around the side of the berg and stirred the water in the lee. However, as things seemed to be getting to a desperate pass, I decided, against my better judgment, to make an attempt. It was from the start almost hopeless. The plane rocked and rolled in the water and with the engine running bucked about on the sea like a thing run wild. Cheesman at the controls did his best to keep the machine on the course and, when in the most favorable position, he gave her the gun. She sprang from wave to wave with leaps like a hunted kangaroo. In the cabin the pounding of the pontoons on the water sounded like the rattle of artillery fire. As soon as our speed began to increase, the shocks, as we struck the high waves, were terrific; and the wooden sides of the machine, where the pontoon bracings are fastened, heaved and buckled. In a few seconds the pontoon gear was so strained that it would have been madness to continue the effort, and, as I was about to give the order, Cheesman cut the gun with difficulty and taxied to the small lee afforded by the iceberg. We were reluctant to give up the attempt and, tightening the pontoons and reducing the load, tried again—this time in the lee of the berg. But the distance was too short, and coming into the wind we almost turned turtle.

Happily the weather was improving, and late in the evening of the 27th the skies cleared. Steaming into the pack we found a stretch

of water comparatively smooth though strewn with fragments of ice. The pontoon gear was reset, and additional bracings were placed inside the fuselage. Once more we went overboard, but this time we were likely to have much trouble with the ice. To touch even a small fragment when skimming along the surface at seventy miles an hour would have rent our pontoons to pieces; and there was no place where we could get a clear, straight run. It was necessary for Cheesman to steer a zigzag course. This he cleverly did, and we managed to get in the air.

First Flight towards Charcot Island

It was good to be under way; but far to the south we could see a great wall of cloud that would surely block our progress. Our position was directly north of Charcot Land, and we headed south for the three peaks that Charcot had charted. There was no sign of land to be seen; clouds and distance hid it from our view. The water from which we had started was thirteen hundred fathoms deep. We flew over scattered pack for fifty miles. There was nowhere a safe place to land. There was a great deal of comparatively open water here and there, caused no doubt by the recent strong wind; but the water was thickly strewn with small fragments of ice that would have wrecked any seaplane attempting a landing. Although there were a number of bergs at the edge of the pack, there were comparatively few inside. Two castle-like bergs with a low flat one between them lay directly in our course and made a good landmark.

From the air we could plainly see the distribution of diatomaceous matter at the fringes of the ice floes and in the scattered pack, and it occurred to me that a survey by airplane of the plankton distribution would furnish the whalers with a general idea as to where whales might be found.

We were flying at 2000 feet, but in half an hour we had to descend to clear the first bank of clouds. Beyond we could see another line of clouds, thick and low. In less than an hour we were flying at 500 feet under a heavy gray mass. Fog appeared in the distance, which when we came to it proved to be hard, dry, falling snow. We were forced down lower than 500 feet. Charcot Land we knew to be over 2000 feet high, and at any moment we might find ourselves at the charted position of the land. There were not only the mountains to think of, but a sudden turn might lose us enough altitude to put us in danger of running into icebergs, if such were in the vicinity. The compass was running wild. There was only the gray blank wall ahead. Beneath us I could faintly see what appeared to be land-fast ice—ice without a crack in it. I asked Cheesman to turn, and as we swung I thought I caught a glimpse of the dark cliffs of Charcot Land looming

dimly through the haze. It was heart-breaking to have reached the land we sought with gas enough to take us at least two hundred miles farther and then be forced to turn back. But there were other things to claim our attention.

Should we be able to find the *Scoresby*? It was our first long flight over the Antarctic pack far from land, and our course in and under the clouds had been confusing. It was with some difficulty that we steadied the compass and set our homeward course. We were beneath the low clouds for a considerable time and could not get a reliable observation for position, speed, or drift. Finally we reached the area of sunshine through which we had flown and were once more able to take observations and check our course. We had scarcely done this when the two castle-like bergs we had passed on our way out came into sight and in a few minutes the trailing smoke from the *Scoresby*.

Our friends on the ship were glad to see us back. They had been worried because our wireless signals had faded now and then. Had we come down, there was hardly a chance for rescue. Out-and-back flights over the broken pack are much more trying and dangerous than a long flight from point to point. One might leave in good weather, fly into bad weather and get into difficulty, and come back to find bad weather had developed at the point of starting. On a long straight flight, when bad weather is met, one can alight, if a landing is possible, and remain until conditions improve.

Second Flight to Charcot Island

We waited, with little grace I am afraid, for the weather to clear, drifting the while farther north, away from our goal. Early in the morning of the 29th the weather in the south appeared to be clearing, and at five minutes past seven we again climbed into the air. The take-off proved better and easier, although Cheesman had to dodge several pieces of ice as we taxied along the surface. We passed over the ship, having first requested her to lie on a true north and south course in order that we in the air might check our compasses. That day, however, we scarcely needed a compass because to the east of us Alexander Island stood out clear and sharp. The bright sun cast dark shadows on the pack and made it easily possible to steer straight and true. Four small icebergs grouped themselves together near the edge of the pack where we entered it, making a conspicuous landmark. We found that the trailing column of smoke from the steamer's funnel, put up for our benefit by the *Scoresby*, showed plainly against a clear sky or against the pack ice, but on that day to the north of us lay a dark bank of cloud against which it was impossible to see the smoke. The vessel itself, not two hundred feet long, was from a few miles away a

speck in the ocean, and without some other landmark it would have been difficult to find.

New Islands Seen to the East

The ice had changed a great deal from its condition when we had flown over it two days before. For twenty miles we flew over pack through which any ship might have passed; but the ice, which in general was scattered, was not sufficiently open to afford a clear space for a take-off or a landing with a seaplane. Between latitudes 68° and 69° in longitude 75° 30′ the pack ice was broken into rough squares about the size of a city block which except in a few places had not changed relative positions. There was open water in the cracks, but it was fast getting covered with the snow drifted by the wind along the surface of the pack. There seemed to be a great deal of snow on the ice, and drifts that had formed behind the lumps of pack were much larger than those we had seen the year before in the Arctic Sea. Most of the drifts had been formed by a northeast wind. From latitude 69° the heavy pack was cracked only here and there, the cracks running irregularly but mostly in a northeast and southwest direction. About twenty miles north of Charcot Land was a belt about ten miles wide of much broken pack and considerable open water. The break-up in the ice had apparently occurred some time previous to our visit because the pack had been twisted and turned in every direction. The snowdrifts were all of a jumble although they had undoubtedly been formed in the same general direction as those a little farther north. The lanes of open water were naturally at right angles to the wind, and while it might have been possible to land in them in a cross wind it would have been practically impossible to take off again. For us to land, however, was out of the question; for by the time we could have walked the twenty miles to Charcot Land and back the leads might easily have closed and pinched our plane.

Mt. Havre on Alexander Island stood out magnificently, and E. de Rothschild Island was most conspicuous. Bearings on these points made it possible for us to fix our position with comparative accuracy. In an hour and twenty minutes after leaving the ship we were at the coast of Charcot Land. Cheesman swung broadside so that I might take a movie of it. A few miles north of the main island there is a small island too low for Charcot to have seen. Our estimate of the position of the north of Charcot Land is within five miles of where Charcot placed it. This is a remarkable agreement considering that Charcot had mapped the land from a distance of fifty miles. The three peaks named by Charcot are conspicuous but not quite in the same relation to one another as they appear on the chart we used, in which the distance between Marion and Martine Peak is about 20 miles, be-

tween Marion and Monique about 7 miles. It seemed to us that these distances should be just about the reverse. We were flying at twenty-five hundred feet, and the peaks were five hundred feet beneath us. From where we first reached land—about latitude 69° 45′, longitude 74° 55′ W.—E. de Rothschild Island bore 70° true. Far to the east we could see two new islands; their most northerly limit bore 90° true, and the most southerly part of the southern island 112° true. They appeared to lie between latitudes 69° 30′ and 70° 30′. The northerly or larger island seemed to be about thirty miles long, crossing latitude 70° in longitudes between 68° and 69°. These two new islands may belong to the group whose most easterly part we saw last year and which we named Finley Islands, but of course we were too far away to chart them with accuracy. The Scripps and Finley islands, discovered and named last year, are low and were so far distant from our position this year that they must have been below the horizon.

In the neighborhood of the two new islands and south of them we could see a few icebergs fast in the shelf ice. The shelf ice was not high at the edge we saw near Charcot Land, not more I think than three feet above the water, probably less, though it is difficult to tell from the air. We judged from the conditions that this shelf continues and joins the part of Stefansson Strait crossed by us last year on our flight to Hearst Land. The presence of icebergs in this shelf ice makes it seem possible that at some time or other the strait has been less solidly filled than it is at present. It is likely that during some seasons it is filled with broken pack. The surface, so far as we could see, was ridged with snowdrifts, and these were old and rounded. The few small bergs that were fast in the shelf ice near Charcot Land and over which we flew were sloped with snow banks from their tops to the general level of the ice on their northern sides but were more steep and abrupt on the southern exposures.

Charcot Island and the Mainland

We followed the coast of Charcot Land from 69° 45′ S., 74° 55′ W. on a course 138° true for twenty-five miles. Then we could see that the coast turned farther southward; and we changed our course to 162° true, crossing a cape for which I have suggested the name Cape Mawson in honor of Sir Douglas Mawson. We continued on that course for twenty-three miles and were then beyond the coast and again over the shelf ice. We turned to follow the general direction of the coast, making a course of 225° true for twenty-five miles.

The coast soon turned more northerly to form a shallow bay. From the position reached we could see, at what we estimated some thirty miles, south and extending to the east and west, a low sloping

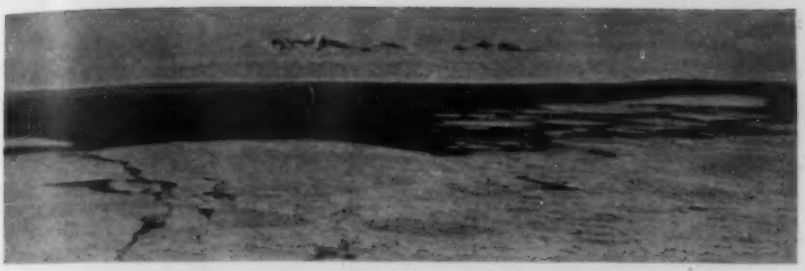


FIG. 19

FIG. 20

FIG. 21

FIG. 22

FIG. 19—A lane of water north of Charcot Island, here about 20 miles distant.
FIG. 20—Charcot Island from about 18 miles away west by north. Cape Byrd in extreme distance.
FIG. 21—The east coast of Charcot Island, Cape Mawson at left.
FIG. 22—Charcot Island from about latitude 70° S. and longitude 74° W.

snow-covered land. It seemed to rise gradually but was unmarked by any dark outcrop or mountain. We believe that it is part of the mainland and that it joins Hearst Land, which we discovered and named last year. We could see the southwest termination of Charcot Land, which we thus discovered to be an island. Its heights in the center were rounded and deeply covered with snow, in places slightly crevassed. There were no rock exposures to be seen except those on the three peaks on the northern side. From about latitude 70° 40′, longitude 74° 30′ we turned and followed a course 305° true for thirty-five miles, crossing over the southwest corner of the island to the west coast. Before we reached the west coast we had been flying for more than half the time that our gas would last, and so we were forced to turn back and make our way to the *Scoresby*.

The southwestern end of Charcot is about twelve miles wide and gives a ham-shaped appearance to the island. It terminates in about 70° 30′ S., 76° 20′ W. At about 70° S., 76° W. and lying southwest of Monique Peak there is a sharp cape for which I propose the name Cape Byrd in honor of Rear Admiral Byrd. Cutting over this corner of the island we turned toward Marion Peak on a course 34° true and covered a distance of thirty-five miles which brought us between Monique and Marion peaks and from there we took up our course for the ship.

My time had been so fully occupied with taking bearings, observations for speed and drift, photographs, making notes on surface conditions, etc., that I had little opportunity to look for signs of penguins or any other sort of life; but no birds came conspicuously to our notice. The snowdrifts on the top of the island ran in so many directions that it was impossible to chart them clearly. It seemed that at an altitude of 2000 feet there had been much greater variety in the wind direction during the winter than there had been at sea level, where the drifts were mostly northeast and southwest. The drifts were comparatively high, and it would have been risky to have landed upon them even with skis. We could not afford a landing as we were fitted with pontoon gear. However, in order to strengthen claims that Great Britain has for many years laid to these areas, I dropped, near Cape Mawson and near Cape Byrd, the British flag and a document claiming the area for Great Britain. The flag was suspended on a parachute so that it might float in the air for some time and after the weight to which it was attached reached the snow. The text of the document is as follows:

> By virtue of authority to do and perform all and every lawful act necessary to take possession of such territories found between the Falkland Island Dependencies and the Ross Dependency in the name of George, by Grace of God, of Great Britain, Ireland and the British Dominions beyond the Seas King, Defender of the Faith, Emperor of India, etc., etc., etc., signed by His Royal Hand and given at the Court

of Saint James on the 21st day of August 1929 I now float His Majesty's flag above this territory and deposit this record at approximately lat.——— long.——— as evidence of this visit and claim, so far as this act allows, this territory, land and sea, in the name of His Britannic Majesty King George the Fifth.

Dated———————

Signed

On this flight of a little more than four hours we had seen three new islands, extended the coast of Hearst Land and Stefansson Strait for a further distance of two hundred and fifty miles, outlined one hundred and fifty miles of the coast of Charcot Land that had never before been seen, and discovered that it was not part of the mainland but an island.

Flight from Port Lockroy to Deception Island

Wind and seas had risen again to a point that would have made a second flight with a seaplane from that position impossible, and so we decided to steam back along the edge of the pack toward Adelaide Island and make a flight from there to Casey Channel and map in detail the Finley Islands. Eastward the weather became worse, so that eventually we brought up in an embayment in the pack near the southern end of Adelaide Island and waited there in the heaving swell for three days without a chance to launch the machine or take off. A flight from that position would have nicely rounded out our survey of that neighborhood, but it was not possible to carry it out.

To see something more of the Detroit Aviation Society Plateau, I decided to fly from Port Lockroy to Deception Island and did so with Parker Cramer at the controls (Jan. 5). There was no wind in the channel, but owing to the current the water was choppy. The coast presented a magnificent sight. In this region I think the Antarctic mountains are most splendid. We flew along de Gerlache Strait and over Trinity Island to the Austin Rocks, which we photographed, carrying out a survey from the air that would be impossible from the surface. The area in that neighborhood is so studded with rocks awash and others just showing above the surface that it is extremely dangerous for a boat to approach.

We landed at Deception Island and found the population quite excited about an earthquake that had occurred two days before. It had rocked the boat as if she were in a heavy sea. A part of the harbor bottom had dropped suddenly fifteen feet, carrying with it the end of a wharf and a section of light railway. The houses on shore, however, were not damaged, and the happening was not seriously dangerous nor significant. The beach at Deception Island is continually steaming, and after the disturbance columns of steam issued from a lake some distance from the beach but soon subsided.

Several hours after our arrival the *Scoresby* reached Deception Island. She had stayed out until almost the last drop of oil had gone, knowing that she could replenish her tanks from the hospitable Norwegians' supply. Their help in this and many other ways has been a great benefit not only to our expedition but to others.

FIG. 23—The seaplane sheltered in the lee of an iceberg.

WESTWARD CRUISE ALONG THE EDGE OF THE PACK

In a few hours it had been arranged with the permission of the Colonial Office in London and its Discovery Committee that the *Scoresby* should return to the Falkland Islands, reprovision and refuel, and return immediately that we might make another venture into the western seas. For two days the vessel was delayed at Deception because of bad weather, and although we even then expected her to return by January 15 it was not until January 25 that she was once more in the harbor. In less than twelve hours our machine and supplies were on board, and we were ready to put to sea. It was almost too late in the season to go forward with our flying plans, but conditions in the polar regions are so uncertain that it is never wise to give up hope without exhaustive trials. In any case, we could be sure of doing a great deal of new and useful oceanographical work.

We had scarcely left Deception when the break in the weather came with high continuous winds from the east. We shaped our course to a point a little south of Peter I Island. It was there that the Norwegian ship *Norvegia*, carrying out scientific research, had last year met the

unbroken pack. Great blue and fin whales sported among the white-caps, and an occasional band of sinister black-and-white killer whales would nose their way about us. We saw no ice until we reached 69° 20′ S. and 90° W.—a position about thirty miles south of Peter I Island. We followed along the edge of the pack which ran between

FIG. 24—Looking down over the pack ice from a position about latitude 70° S. and longitude 101° 20′ W.

latitudes 69° 20′ and 69° 30′ until we reached longitude 99° 50′ W. and then turned southward into what appeared to be a small bight in the pack.

FLIGHT OVER THE PACK ON JANUARY 30

The weather had not improved: the sky was covered with low clouds, and to the south snow squall after snow squall moved from east to west. In the lee of an arm of the pack was a sheltered strip of water, and hoping that the weather to the south might clear we prepared to launch the plane. We then discovered that the frequent changes in temperature since we left Deception Island had set up much condensation in the fuel tanks and that the below-freezing temperatures which we were then experiencing had frozen the water solid in the pipes which should have carried the gasoline to the engine. It was necessary to remove practically the whole of the fuel system and heat it to melt the ice. By the time that work was done the weather was almost calm, and we put the machine overboard. The water surface by this time was almost too smooth for a seaplane to take

off, but by taxiing into a snow squall coming in our direction we managed to get into the air. We soon saw that the way to the south was barred; the snowstorms in that direction became constantly thicker. It was not possible to see far ahead even by flying low over the ice. Conditions were dangerous, and no good service could be done by flying blind over the pack.

Swinging out towards the edge of the pack we discovered that the ice a little to the west of where we had launched the plane turned sharply south. We returned to the ship, hoisted the plane on board, and proceeded along the edge of the ice. The calm spell had lasted but an hour or so, and the wind rose again. We crept along to 70° 10′ S. and 100° 45′ W. At that point the ice pack turned northward again, and there we awaited better weather. Our wireless had failed to penetrate the obstacles between us and Deception Island; and, while it was possible for me to pick up stations throughout the world and hear broadcasting over the short wave, it was not possible for us to communicate with our base. Low cloud and frequent snow squalls continued, and well inside the pack the swell was high.

At last there came a change in the wind. It veered round to the south. This tended to clear the weather but, coming across the swell, knocked up a choppy sea. Near the ship there were fifty or more small bergs in sight, including one to which some earth and rocks were clinging. In the distance it might easily have been mistaken for a rock-scarred mountain. Many of the bergs in this vicinity were not high, probably less than ten feet above the water, their surfaces covered with a layer of snow three to four feet thick. They came no doubt, driven with the easterly wind, from somewhere between our position and Charcot Island.

By the morning of February 1 the weather was clearing, but scattered snowstorms still drove past us and blotted out our visibility. By noon the wind swung more to the westward; and, fearing that the weather would set in thicker, I decided in spite of the choppy sea to attempt a flight. In the last few days there had been a considerable variety in temperature, and again there was trouble in the fuel lines from condensation. It was two in the afternoon, local time, when the machine was ready for the water. Mr. Bowers, mate of the *Scoresby*, Mr. Knowles, the boatswain, and the crew were by this time becoming accustomed to handling our plane and did their work skillfully and well. On this day it was just twelve minutes from the time we started to remove the lashings that held the machine to the deck until we were in the air.

Flight over Pack on February 1

We swung over the ship as usual to test our compasses and then, turning slightly west of south, flew under a lowering clouded sky. The

ship was soon lost to sight, but the berg with the earthy face was a conspicuous landmark. At 500 feet the drift caused by the southwest wind was about fifteen degrees. This somewhat checked our forward speed. Some of the clouds were up to 1000 or 1500 feet. We climbed to that altitude, but there the wind was stronger and more turbulent. We descended again, but even at 500 feet we had to fly through wisps of cloud. No sign of the sun could be seen. The light conditions over the ice were the worst possible for navigation and flying. Rough ice could scarcely be distinguished from smooth, and the young ice that had formed over the patches of water between the thicker pack rendered its presence inconspicuous but just discernible. These dull gray patches and the occasional windrows of new snow across the older yellowish pack—telltale marks to those experienced in polar conditions—served in a measure as aids to navigation and helped Cheesman who was piloting to keep a more or less steady directional course. The air was so rough that it was impossible to keep the machine on an even keel, and this made it difficult to check our true speed over the ice. Although there were numerous bergs here as at other points from which we flew at the edge of the pack, there were comparatively few to be seen farther south. On that dull day only a few could be clearly distinguished from any distance, and these were the ones that had vertical sides with brows of snow projecting over their tops and giving the appearance of a shadowy pencil line along their upper edges.

When the ship hove to beside the pack we thought that we were at the foot of a bight and that the main pack ran far to the north and west of us, but from the air we could see that it was only a narrow tongue that projected northward and that the main trend of the pack was to the southwest. At latitude 71° the pack ceased its southern trend and extended westward as far as the eye could see. As far as this point the ice over which we passed was such that a strong ship might have forced a way through, but beyond 71° the floes were larger and only slightly scattered. Some of them were large enough for a landing field and, under the low cloudy surface and to the inexperienced eye, looked smooth and flat enough for skis. But with the experience of eight polar summers behind me, I could detect the slightly mottled surface indicating the wind-driven snow banks stretching out behind the irregular blocks of rough ice. It was only the peculiar light conditions that made these floes appear to be smooth and level. Not once have we observed in the Antarctic pack ice suitable landing fields such as we saw frequently in the Arctic north of Alaska. A skillful pilot might make a safe forced landing at some places, and no doubt the surface of the land-fast ice would serve for a satisfactory landing field.

The weather gave much concern. Ahead it looked black and forbidding, a big snow squall lying across our path. As we ran into

the frozen cloud we experienced a peculiar condition. The temperature increased by three degrees. It was 27° F. at the edge of the pack. The warmer, damper air filled the cabin and cockpit of the plane as if with the smoke of many cigarettes. The engine also felt the change, and I worried somewhat as the revolutions died slowly down. Cheesman replied to my inquiry that he had not changed the throttle, and even when he tried it in several different positions the engine failed to recover. We sank low in the misty air. Gradually we flew clear of the storm, and the damp air cleared away; the engine picked up, and we plugged on southward. Beneath us a few seals lay like dead flies upon a huge white sheet; if we passed directly above them they would roll lazily over on their backs to watch us as we passed, waving their flippers as if in a friendly greeting. The sight of these living creatures upon the forbidding ice pack somewhat relieved it of its terrors and gave us comfort.

"Appearance of Land"

After we had been flying for fifty minutes Cheesman excitedly drew my attention to a long dark-looking mass looming through the gray mist to the southwest of our course. It was exactly in the direction in which lay Captain Cook's "strong appearance of land," so marked on Admiralty Chart 3175 (Antarctic Regions, Sheet VI, 1929)[2], and because of which I had set my course a little west of south. "Shall I make for it?" he shouted. With a caution born of many disappointments after hurried judging of polar conditions in poor, hazy light, I replied "Let's keep our course for a few miles farther. If there is any doubt at all about it being land, you can almost be sure that it isn't." With the little five-power binoculars which I have found most serviceable in our planes I scanned the horizon before us. Slightly on our left hand—that is to the eastward of our course—I could see another dark splotch and yet another dark gray mass still farther to the east. It must be the land behind the barrier, I thought. If that was so we should strike it by going straight ahead. By this time it was again necessary to take an observation for ground speed and drift, and I was astonished to find that our forward speed had increased without advancing the engine throttle. We had evidently run through the wind that had been interfering with our

[2] Cook's narrative contains no mention of "appearance of land" at this, his most southerly position, 71° 10′ S., 106° 45′ W. (A Voyage towards the South Pole and Round the World Performed in His Majesty's Ships the Resolution and Adventure, in the Years 1772, 1883, 1774, and 1775 (2 vols., 2nd edit., 1777), Vol. 1, pp. 267–268). He describes the vast ice field by which farther progress southward was arrested, its "ice hills . . . many of them very large and looking like a ridge of mountains . . . seemed to increase in height as you traced it to the South." He expresses the opinion that "this ice extended quite to the pole, or perhaps joined to some land," and goes on to say that but few birds were seen "or any other thing that could induce us to think any land was near. And yet I think there must be some to the South behind this ice."—Edit. Note.

progress. The plane sped straight ahead without drifting. This was not an unmixed blessing. So long as the wind held we might expect at least intervals of clear weather between the snowstorms, but if the wind dropped the atmosphere would get more and more hazy until a fog developed. I looked again at what we believed were great dark land masses. The prospect was still hopeful, and traveling at a speed of 125 miles an hour we expected soon to reach the nearest mass and know for certain.

About that time I looked below and was much startled by what I saw. There, it seemed, were two men running for their lives. The shock was instantaneous and was over almost as quickly. They were great emperor penguins of course. Yet from the air they looked exactly like those wild Siberians we had seen running helter-skelter from the shadow of the *Graf Zeppelin* as we crossed the northern wastes on the round-the-world flight. We could not help but laugh loudly at the comic figure they cut and craned our necks to watch them as they were speedily left behind. Never once did they hesitate or stop to look around. With their broad backs towards us, their bodies swaying like pendulums, they hurried from the thundering noise of our engine. We left them with the impression that they would run on forever.

Then we looked again for the supposed land ahead. On both sides in the distance there were strong appearances of land; but the closest dark area we could see soon took the form of a long, low berg. We could not imagine why it looked so uniformly dark in contrast to the smaller bergs which were almost lost in the haze of the sunless day. As we neared the berg the problem was solved. On the side next to us was a narrow strip of open water, black in comparison with the dull gray of the other openings thinly covered with young gray-colored ice. Evidently the drift of the berg in the current set up such a disturbance in the water that the ice could not collect near its edge, and the clear dark water reflected on the sheer side of the crystal berg gave it a close resemblance, when viewed from afar, to a low snow-covered land mass. It may have been that the bergs were aground and the pack drifting past them left a patch of open water in their lee. The darkness was on the lee side when the wind blew from the west as it had done a few hours before, but as we flew at five hundred feet the air was calm in that vicinity.

In a few minutes we could see that the objects on either side of us were also icebergs and not land as we had hoped. The conditions were probably similar to those that have led to so many false reports of land in the Antarctic. Disappointed we continued on our southward course. Ahead the wall of snow cloud that barred the way had too wide a frontage for us to circumvent, and it was no use trying to get on top. We lost sight of everything except that immediately beneath us. Cheesman no longer had a distinct horizon to fly by. Twenty

degrees to the one side and then to the other we would swing, and it took all my time to record the progress of the plane and keep check of our position. I had no time to keep watch through the cabin windows and see what we were flying over. At times a quick glance showed me that we were still over floe ice, ice that was split and cracked but not badly broken. We were down to one hundred fifty feet, and it was not possible to go lower with safety. It was not as if we were flying over the Arctic ice where we could have come down to fifty feet without fear of running into anything. At any point in the Antarctic pack we might strike an iceberg a hundred and fifty feet high or even higher. To fly long in such thick haze would mean that we should soon be flying round in circles and, losing all sense of direction, fail to find our way out of the snowstorm or back to the *Scoresby*.

Conclusions Regarding Mainland

We kept on for a full ten minutes. It was then an hour and a half since we left the ship, and in that elapsed time we should have reached at least latitude 73°. Judging by the soundings taken farther north we might well expect to have reached land. But still dimly beneath us I could see the faint outline of fractured ice floes. As at Charcot Island we were unable to come down on the ice. Our vision was restricted; but, as we were undoubtedly above ice more or less firmly attached to the mainland, as at the other points visited, I dropped the British flag suspended from a parachute together with a proclamation claiming as far as such claims may, that area, land and sea, for the British Crown.

Our later discoveries some distance farther east might have some bearing on the fact that the land in the longitude and latitude in which we flew was some distance farther south than we expected. To the east we found that the sea bottom shallowed to less than five hundred meters and then got deeper again. This may be the case in 100° W. The gray, misty, snowstorm had closed us in completely. To make a right-about turn and steady our compass was not an easy matter; but Cheesman finally managed it successfully, and after twenty minutes effort we emerged into a clearer atmosphere. We set our course for the edge of the pack, now far out of sight to the north. It is probable that in clear weather, from our farthest south, we could have seen land ahead; but we saw no definite indication of it.

Annual Variations in State of the Ice

By flying very low on our journey back I could see that the greatest snowdrifts had been formed when the wind blew from the southwest or the northeast, the drifts formed by the southwest wind being slightly the greater. There was no evidence of winter fractures or

pressure in the floe ice, and the surface was still slightly roughened by the tops of what had been at one time broken pack ice. Evidently the floe ice was not many years old, or else the snowfall in that district is not great. Judging from the thickness of the snow on the ice near the edge of the pack, however, it appears that the snowfall last season exceeded two feet in thickness since much of the ice we observed in February had that thickness of last season's snow still upon it. At times, it seemed to us, the ice must break away from the edge of the thick floating barrier or shelf ice; and sometimes a section of the shelf ice comes with it, as is evidenced by the low flat bergs to which the pack ice still adhered. This seems to indicate that the breaking of the ice from the barrier is periodical but not necessarily annual.

One thing that seems to bear out this theory is the fact that this year there are so many icebergs at the edge of the pack but comparatively few within the pack itself. The breaking off of the bergs probably has some influence on the drift of the ice, as they are subjected with their greater depths and height to much pressure from the wind and currents. The ice this year except in the neighborhood of Charcot Island so far as our investigations went would probably not move far from the continental edge. It is my opinion that no surface ship no matter how strong could have pushed through it to a point south of latitude 71° between the Antarctic Archipelago and longitude 100° W. There was no possible chance, so far as we could see, of a ship ever reaching the barrier; because, even if the ice was broken from its edge, the band of pack would still be too formidable. It is doubtful if a surface vessel could even reach floes of sufficient size and nearness to each other to enable a landing party to walk from ship to shore. This season, so far as we could see in the areas visited, even the edge of the fairly solid pack was more than one hundred twenty miles from the land-fast ice, a distance far too great for any landing party to attempt to draw their supplies on sleds unless of course they were prepared to live on the resources of the country or expected to come directly back.

Establishment of Meteorological Stations

It seems unlikely, therefore, that we can hope to establish yearly boat communication with a permanent base on the coast line near longitude 100° W.; and, because it is of great importance to the comprehensive study of Antarctic meteorology to have a station in that region, we must look for other means than surface ships to help us. It is possible, of course, to fly over the pack ice as we have done; and, if a party is in the condition to wait for suitable weather, no doubt on some day in the summer season a flight to a southern base could be made. But the chance of finding clear weather conditions together with favorable seas for a take-off with great loads is so uncertain as to

make that method of establishing and maintaining a base uneconomical. It might be done by going with a vessel carrying planes and prepared to winter in the pack, since in the early spring a runway could be made on the ice and the necessary flights carried out by the use of skis.

I believe the problem could be solved more easily and economically by the use of a submersible vessel which would go under the pack and come up near the land or at the solid edge of the ice shelf. Such a vessel could carry airplanes if necessary and would be more certain of accomplishing the work. The bergs in the pack, if this year's conditions are typical, would present no great difficulty to a submarine. The bergs were widely scattered and comparatively small so that it would be easy to go around them. During our flights over the pack we never saw a floe more than ten miles wide, except on the solid practically land-fast ice in Stefansson Strait and south of Charcot Island. It seems to me that, while icebergs might be a slight hindrance to the use of submarines in the Antarctic, they are not impossible to cope with; and it is my opinion that some time in the not distant future the submarine will help solve the many difficulties of establishing bases and carrying out detailed scientific work in the Antarctic as well as in the Arctic.

Return to the Ship and to Deception Island

These things passed through my mind as we flew back towards the *Scoresby*. Meanwhile the task of finding the ship was not an easy one. We had undoubtedly flown a somewhat muddled course when lost in the clouds and snowstorm; so to make sure of finding the ship I decided to keep well to the westward until we should strike the edge of the pack and then follow it until we came to the *Scoresby*. This plan of making sure to be on one side of the destination until you seem to be opposite to it and then turning at right angles is one that was thoroughly drilled into me by Stefansson in the Arctic, and time after time I have proved its value.

We flew to the edge of the calm, hazy belt through which we had passed on our southward journey and after passing through it came again to the westerly wind. Now it was in our favor, and soon after passing under a low thick cloud we could see the dark loom of the open sea ahead. And a relief it was to tired eyes, for we were well on the way to snow blindness through intense scrutiny of snow cover and haze.

Flying low along the edge of the ice we noticed that the temperature had dropped and the wind had increased. No snow had stuck to the wings of the machine during flight, but the struts and propeller were at times lightly coated. We swung over the *Scoresby* and alighted. No sooner had we struck the water than the spray from the waves

froze to the pontoons and the ice began to pile up in alarming quantities. With all haste the machine was hauled on board. Had there been such a temperature when we attempted to take off, we should not have been able to start.

The wind increased, and the sea ridged the pack in swathes fifteen to twenty feet high. It would take several days for the swell to subside. We had completed the main object of our investigations in that part of Antarctica, and so while the weather was clearing we edged our way along the ice in the direction of Charcot Island. Three times when the wind died down and the weather cleared somewhat, we brought up beside the pack; but the swell of the sea was at all times too great to launch the plane. At each place a series of oceanographical observations were carried out, and many things of interest were collected by the biologists on board. The report on the oceanographical work done will be published by the British Colonial Office.

As we were again coming to the end of our fuel supply we turned still farther northward, the weather never for a moment improving. Then after a period of interrupted communication with Deception Island, we received a message that the *Henrik Ibsen*, which had carried supplies to the whalers, would proceed in two days to Montevideo. If we could return at once she would carry us back to civilization. If we missed that boat we might lie idle for six weeks. In increasingly bad weather we headed with all speed toward Deception. The transport wirelessed that she could not wait more than two hours beyond her scheduled time for leaving. I asked our friend Sverre Nielsen, the manager of the Deception Island whaling station, to place our second machine and the supplies at Deception on board the transport, and we arranged everything on the *Scoresby* so that we could transfer our load to the transport as soon as we were in the harbor. Early in the morning the wind abated, and by running full steam ahead we managed to reach Deception on February 14 exactly at ten o'clock, the time at which the steamer was to sail. In less than two hours we were steaming toward Montevideo.

APPENDIX

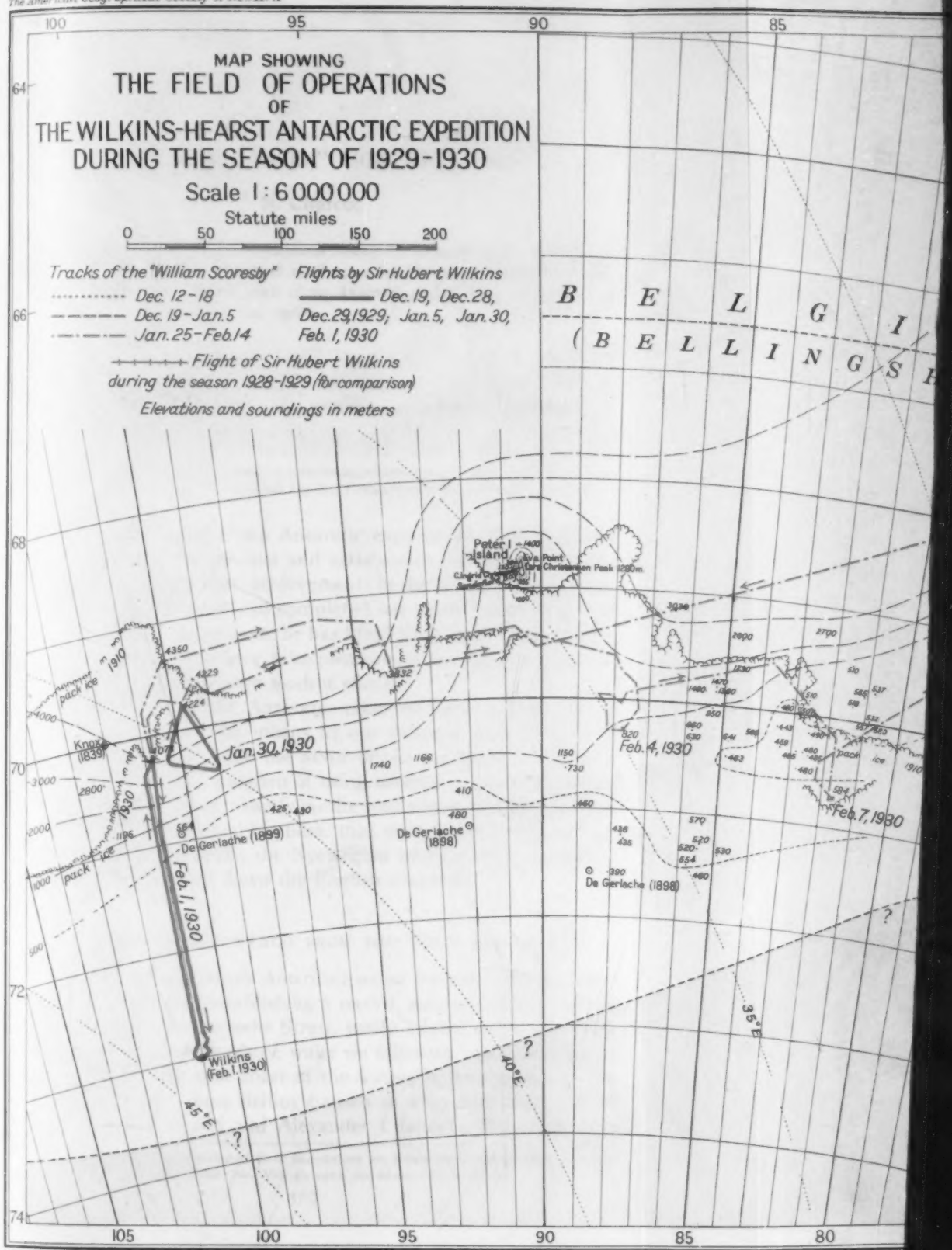
Acknowledgments and Equipment

The 1929–1930 expedition was made possible by considerable financial support from the British Colonial Office and the aid of the R. S. S. *William Scoresby*. By using for this and the previous season's work equipment already paid for by service in the Arctic the expedition was relieved of considerable expense (see Appendix "Acknowledgment and Equipment," The Wilkins-Hearst Antarctic Expedition, 1928–1929, *Geogr. Rev.*, Vol. 19, 1929, pp. 375–376). Transportation, wages, and traveling expenses were the principal items of expenditure. In addition to the *William Scoresby*, whose captain and crew greatly facilitated our labors by their cheerful and efficient help, we are particularly indebted to the N. Bugge Hektor Whaling Company, to their transports, and to the manager of their Deception

Island station, Sverre Nielsen. Many passenger-shipping concerns have given us service at cost of operation, and because of the smallness and mobility of my party the total expense for our two seasons' work in the Antarctic amounts to less than $60,000.

Our planes, used last season, were stored at Deception Island. We carried with us new supplies of Vacuum Mobiloil and Plume gasoline for our airplanes. Our food consisted of pemmican, Freia chocolate, Saetre biscuit, Horlick's malted milk, together with nuts and raisins. Our clothing, which proved as adequate as our other supplies, was made up of Eskimo fur suits, Worumba camel's-hair cloth, Burberry wind-proof suiting, and Jaeger socks and underwear. Besides our flying machines we had need of light mechanical ground transportation; and we found the Cletrac caterpillar tractor presented by the Cleveland Tractor Company, the Evinrude outboard motor loaned by the Outboard Motor Corporation of Milwaukee, and the Austin Seven motor car each indispensable and perfect of its kind. The Cletrac with a Fresno scraper did the work of thirty men in clearing the runways, carrying our supplies, and moving our planes from one place to another. We should have been at a great loss without it.

In the field the work has been carried out by a staff of four men besides myself. Parker Cramer and S. A. Cheesman, the pilots, while new to the Antarctic, had already proved their mettle in the far North, Cheesman as pilot of the Northern Aerial Mineral Exploration Company of Canada and Cramer when flying to Greenland and Labrador in successive efforts to cross the Atlantic last year and the year before. Orval Porter, as on the other trips when he has been with me, proved to be the backbone of the expedition by keeping our engines in such excellent condition that in three years we have not had a single forced landing. We are much indebted to the *San Francisco Examiner's* wireless services. Under the direction of Mr. Martin we received messages for us and transmitted ours direct to San Francisco. The Hearst Examiner Wireless K. U. P. broadcasting news kept us in touch with the events happening in the world, and each day we had our newspaper. The wireless correspondence was in the efficient and painstaking charge of Vigo Holt of Montevideo who had been with us in the Antarctic the previous year.



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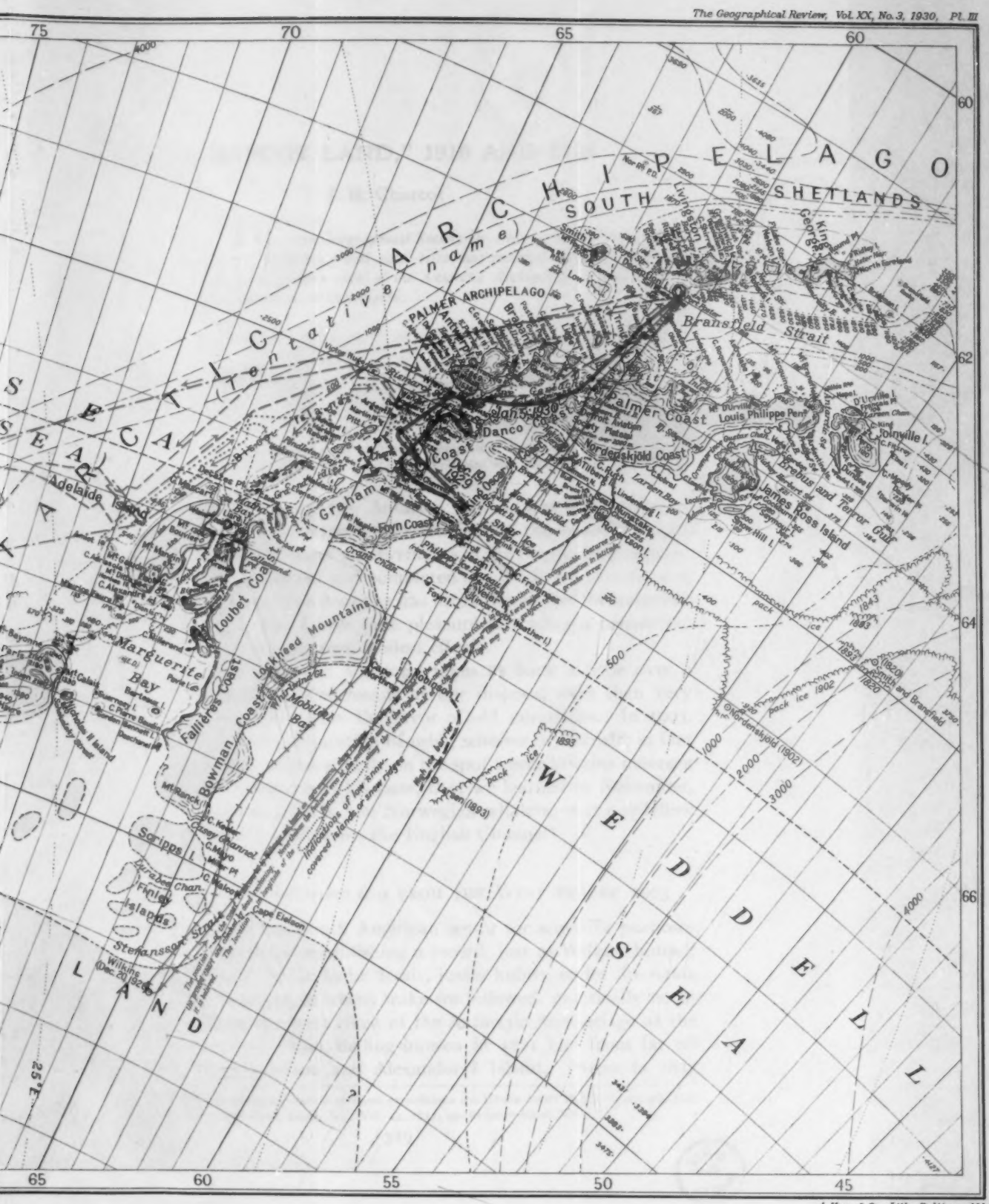
85
80
75
70
65
E L G I C A
E L L I N G S H A U S E N S E A
Adelaide
Dec. 29, 1929
Dec. 28, 1929
Alexander I Island
Rothschild I.
Cape Byrd
Monique Pt.
Marion Pt.
Martine Pt.
Charcot I.
Cape Mawson
Wilkin's
(Dec. 29, 1929)
Mt. Bayonne
Paris Mt.
Mt. Hope
Feb. 7, 1930
4, 1930
(1898)
H E A R S T
35°E
30°E
25°E



A. Hoen & Co., Lith., Baltimore Md.

"CHARCOT LAND," 1910 AND 1930

J. B. Charcot

At the request of the American Geographical Society Dr. Charcot, leader of the French Antarctic Expeditions of 1903–1905 and 1908–1910, has reviewed Captain Sir Hubert Wilkins' operations on the western coast of the Antarctic Archipelago, 1929–1930, in the light of his own experiences in that region.

FIG. 1—Charcot Island bearing southeast. A hitherto unpublished sketch drawn from the mizzen top of the *Pourquoi-Pas?*, January 11, 1910 (see Fig. 3). Compare with Wilkins' Figure 20, p. 375.

THE members of my two Antarctic expeditions[1] have followed with the greatest interest and satisfaction the splendid results of Sir Hubert Wilkins' achievements in the South Polar regions. Not only has he continued and completed our work, confirming, and utilizing the little we have done; he has lifted the veil on the unknown we were seeking. And I here take pleasure in tracing a connection between his work and our own modest efforts.

My own entry into the Antarctic takes us back a little over a quarter of a century. The means at our disposal were then very primitive: already they have the savor of old curiosities. In 1903, as in 1910, there was no question of using wireless or aircraft; in fact it was in Deception Island, exactly on the spot where Wilkins nineteen years afterwards established his base, that we learned in November, 1909, from our good friends, the Norwegian whalers, that our fellow countryman, Blériot, had flown the English Channel!

THE ANTARCTIC ARCHIPELAGO FROM THE WEST BEFORE 1903

We had chosen the South American sector for scientific purposes without any attempt at establishing a record, just as Wilkins himself has done. Beyond de Gerlache Strait, justly known under the name of the Belgian explorer, in whose wake we followed, practically nothing was known of the west coast of the Antarctic Archipelago at the time of our arrival. Von Bellingshausen in 1821 had from far off discovered Peter I Island and Alexander I Island. Biscoe in 1832

[1] For a contemporary appreciation of these expeditions see Edwin Swift Balch: Charcot's Antarctic Explorations, *Bull. Amer. Geogr. Soc.*, Vol. 43, 1911, pp. 81–90.—EDIT. NOTE.

saw at a distance an island he named Queen Adelaide; he landed on one of a string of small islands which since carry his name and saw in the background a land of bold and lofty mountains to which he gave the name of Graham Land. Dallmann, with the first steamship to penetrate into the Antarctic, discovered Bismarck Strait in 1874 and roughly charted its coasts and islands. Evensen approached Alexander I Island but brought back no precise or new information. De Gerlache in 1898, after having discovered, navigated, and mapped his strait, went south as far as what we have since called Beascochea Bay. He sailed parallel to the Graham Coast hidden from him by haze and fog, had a distant glimpse of Alexander I Island, and pushing bravely in the pack was caught in the ice; he drifted south of Peter I Island, passing the first winter in the Antarctic and thus opening the road to modern scientific expeditions.

In 1903 the Graham Coast appeared on the maps as a nearly straight dotted line trending southwest and gradually disappearing; parallel to this line some of the Biscoe Islands were vaguely traced, the last of them being the eight-mile-long Adelaide Island; in the southwest appeared a timid indication of Alexander I Island, and that was all.

Expeditions of 1903–1905 and 1908–1910

Our first expedition (1903–1905) discovered and mapped Ports Lockroy and Wandel and brought back a very precise chart of the north coast of Palmer Archipelago, Bismarck Strait, the Argentine Islands, and some of the Biscoes.[2]

Our second expedition in 1908–1910 completed the former charts, adding a new map of Deception Island[3] and one of Port Circumcision, Petermann Island; the whole length of the coast was charted as far as latitude 70°, including the three quarters of Alexander I Island that we were lucky enough to approach within a few miles; a new land, named after my father, Professor Charcot, was discovered. Then, following the pack ice, we sighted Peter I Island, not seen since Bellingshausen; after navigating between latitude 68° and 71° S. we turned north at longitude 125° W. without having detected land, though our frequent soundings showed a progressive diminution in depth.[4]

I may say that the surveying work we did was good; and this without vanity, as the entire credit goes to the French naval officers, Matha and Rey, seconded by the other members of the staff, Gourdon, Pléneau, and Turquet in 1903–1905, and Bongrain, Godfroy, and

[2] Expédition Antarctique Française (1903–1905), commandée par le Dr. Jean Charcot: Hydrographie, physique du globe, by A. Matha . . . J. J. Rey . . . , Paris, 1911.

[3] Cf. *Geogr. Rev.*, Vol. 19, 1929, p. 373.

[4] Deuxième Expédition Antarctique Française (1908–1910), commandée par le Dr. Jean Charcot: Cartes, Paris, 1912.

Rouch seconded by Gain, Gourdon, Liouville, and Senouque in 1908–1910. The mapping was completed by numerous photographs and a continuous series of coast panoramas extending from de Gerlache Strait to Charcot Island.[5] The west coast of Graham Land lost its hypothetical lineal aspect; it was shown to include lofty mountains cut into by deep and numerous indentations with bold cliffs, inlets,

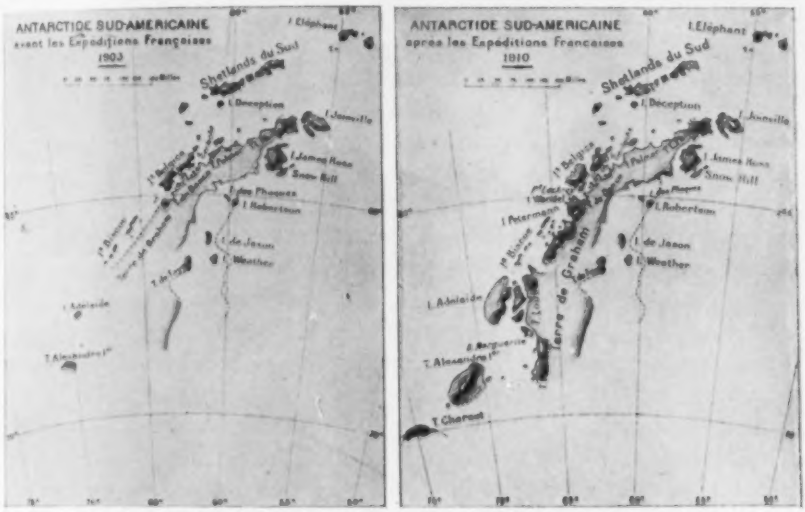


FIG. 2—The Antarctic Archipelago before and after the French Antarctic Expeditions of 1903–1905 and 1908–1910.

fiords, and perhaps openings of straits or channels; a jumble of reefs, sunken rocks, and small islands formed a sort of parallel rampart. Adelaide Island turned out to be bean-shaped and 70 miles long instead of 8; south of this, the coast of the extensive Marguerite Bay seemed to terminate at latitude 69° by a cape; Alexander I Land had all the appearance of an island separated from this cape by a broad strait, and separated similarly on its west side from Charcot Land, which, according to the humor of the day, we now considered as a headland and now as an island but with a marked predilection for the latter.

What lay south and east of Cape Pierre Baudin limiting Fallières Coast? More land or an opening to Weddell Sea? What lay south and west of Charcot Land? Would this, the most southerly *terra firma* then known in this region, be one day reached, studied, and used as a base? For twenty years these questions and many hypotheses in answer have vexed my brain, sleeping and waking, always with the underlying query: "Did I do all that was possible to solve the problem?" Sir Hubert Wilkins lays before us the solution and at

[5] *Ibid.*: Description des côtes et banquises, instructions nautiques, Paris, 1914.

the same time, I am happy to say, removes my scruples by showing that we could not have done more.[6]

Comparisons of Ice Conditions

Let us now follow Wilkins and compare some of the conditions he met with on his 1929–1930 expedition with those we found some twenty or twenty-five years before.

Port Lockroy, when visited by Wilkins, was full of broken ice rendering it unsuitable for a seaplane to take off: evidently this happens frequently, but on many occasions we found this harbor absolutely ice-free. The entire cruise of the *William Scoresby* in search of favorable conditions for a take-off, either from ice or from open water, shows the constant variability of the ice conditions in this region. We frequently observed the like ourselves; and this characteristic combined with the very rapid changes in weather, the strength of the gales that raise a big swell and high breaking seas, the submarine reefs that rise like pinnacles from the depths, and a continuous breaking off of ice blocks or icebergs from the glaciers to render surveying and even navigation particularly difficult and dangerous along these coasts. I should never dare assert that in such or such a place such or such conditions would be likely to be met with. I should cautiously prefer simply to indicate what I had observed at a given date.

Thus in January, 1909, Wilkins would have found in the southeast and east of Marguerite Bay a splendid expanse of good, thick, and strong flat ice favorable for a take-off and a landing; his ship could have come alongside as easily as if it were a wharf. Matha Bay presented the same conditions.

In February, 1904, we remained ten days repairing our boilers alongside ice that was four meters thick and filled the whole of Flanders Bay. Viewed from the masthead this ice seemed flat, but our excursions proved that the surface was channeled as if it were a long swell solidified, and this might have been a dangerous disappointment for an airplane. In December of the same year beautiful-looking flat ice extended from Petermann Island to the Argentine Archipelago; during one of our excursions five of us crossed this ice, hauling a whaleboat; alas, in too many places we met with the two layers of ice of which Wilkins complains in Beascochea Bay; his description recalls our strenuous efforts, waist high, in icy water.

The occurrence of free water spaces is equally precarious; one out of many examples will suffice. On January 4, 1909, the sea was

[6] Intentionally I do not dwell on the information given by Messrs. Chr. Salvesen & Co. of Leith that two of their captains had reached in February, 1924, the southwest point of Fallières Coast and reported an open gulf that might be the west end of Stefansson Strait. I do not assert that it is not so, but the information I received and the rude chart I was shown suggest a certain confusion.

absolutely free of ice between Petermann Island and the Argentine Islands; with Godfroy and Gourdon I took the motor launch out, expecting to be back to the ship in a few hours; in less than 45 minutes, while we were climbing to the summit of a small island, the whole free space was filled with ice, and we were ice-bound for four days.

In fact, "Carpe diem" should be one of the dearest mottoes of the traveler in this part of the world. Wilkins stuck to it against painful strain on his patience and activity; he showed at all events great courage in not being too foolhardy, though he is one who can afford this luxury.

In his first flight Wilkins ascertained that the distance between Flanders Bay and Evans Inlet is very short. This information revives my regrets. Advised by de Gerlache, we had planned in 1904 to use Flanders Bay as a base to cross the land from one sea to another; weather conditions did not allow us to execute our program but Wilkins' flight proves the judicious foresight of the Belgian navigator. The investigation of Beascochea[7] Bay was one of our goals; de Gerlache on his map had noted "extensive bay or strait"; after many vexatious and unsuccessful attempts it was only in March, 1909, that we, in our motor launch, were able to avail ourselves of a few hours of free water, during which time we explored and mapped this weird and awesome fiord.

A Cloud Illusion

Wilkins tells us of the cloud illusion he experienced while flying to Richthofen Valley; a similar adventure befell us in neighboring quarters. With four of my staff and crew I had climbed a 400-meter summit. Looking southeast we cried out with joy and astonishment when, before our eyes, stretched a large strait dotted with small islands and certainly leading to Weddell Sea; we got to work immediately, my comrades sketching while I took bearings and commenced mapping. Alas, about an hour later, what had appeared to be endless pack ice extending as far east as the eye could see was in reality a mass of soft white-topped cloud, the islands being the emerging tops of the mountains. For curiosity's sake I have kept the documents concerned; they prove the errors that can be made with absolute good faith, and they are a caution against too hasty conclusions. Of this, Wilkins cannot be accused. Though convinced of the existence of Crane Channel, which he discovered last year while flying along the east coast, he wished to have the proof by following it in all its length. Circumstances unhappily did not give him the chance, and his own restrictions admit the possibility that two fiords, one east and the

[7] Beascochea is the name of an officer of the Argentine navy to whom our expedition was particularly indebted. We have tried to recognize the interest and generosity of all those who helped our expedition by giving their names to geographical features. This is why so many Argentine names are mixed with those of other nationalities and France.

other west, might be opposed at their heads like Flanders Bay and Evans Inlet or like numerous instances in the Faroes and Kerguelen Islands. Nevertheless, for my own part I believe that this channel does exist, leading in the west into what we named Auvert and Marin Darbel fiords. When in 1909 we discovered Matha Bay, into which these fiords open, we all had the impression, frequently stated since by many of us, that we were at the entrance of a strait blocked by ice.

Confirmation of Charcot Land and the First Sighting

Wilkins' second flight, which fell short of Charcot Land, was too impeded by atmospherical conditions to permit the bringing back of geographical information, but it contributed largely, with the others, to give an excellent technical lesson. The third flight naturally is the most interesting for us. Relying on our mapping, Wilkins and Cheesman, bearing on E. de Rothschild Island and Mt. Havre, Alexander I Island, arrived directly over Charcot Land. Wilkins estimates that the position of the northern shore of this island is within five miles of where we placed it; and I am not loath to admit with him that "this is remarkable," as once more all the credit is due to Captain G. Bongrain, then Lieutenant of the French Navy, who was in charge of the surveying operations; but, knowing the capacity of this officer, I am not astonished at the result.

The three peaks, Marion, Monique, and Martine, named after my daughters, have been recognized and are the only bare land protruding from the ice cap. To see our discovery confirmed, to look at the photographs and read the details, is an immense and thrilling satisfaction. As this land now belongs to history, it may be interesting, or at least amusing, to hear how it was seen for the first time. I cannot do better than quote from my personal log book.

January 10, 1910 . . . We ought to be in the whereabouts of latitude 69° S.; we stop to take a sounding and find 455 meters. In clear weather we ought to have an interesting view of Alexander Land.

January 11 . . . I have had the ship brought to under short sail during the night hours. I will not leave this place before having had a good clear-up, and I expect some few hours of fine weather after the northeast gale which has just subsided—though actually it is snowing. In the early hours it alternately cleared up and shut down; about nine o'clock from the crow's nest I thought I saw something strange in a southeasterly direction. Is it an iceberg or . . . ? I dare not write the word. I am so afraid of making a mistake that I keep what I have seen to myself. Just to pass the time I send a boat to bring back a ton or two of iceberg ice for fresh water. At midday the sky clears up, and I anxiously scan the horizon; far off in the pack is Alexander Land that we see under a new bearing, but closer to us I see what I had noticed a few hours before, and now I am convinced. Nevertheless I still keep silent, waiting for greater certitude. I send orders to the engine room, and to everyone's astonishment, contrary to former orders, I steer the ship on an easterly course. After a hasty lunch I climb back to the masthead and call Bongrain; giving him my binoculars I point out the direction in which he must look,

telling him to answer in a low voice; he only finds one word, Oh! We go ahead, and now I can announce my discovery, which brings almost everybody with a bound on deck. We make out two high mountainous masses, from which black rocks emerge, and between them a smaller mass, springing as on Adelaide or Alexander Lands from a large cap of ice somewhat lower, which seems to extend very far east and west, though sharply separated from Alexander Land south of which it lies. It appears to me that there are some high peaks on the horizon, passing behind Alexander Land in the direction of Fallière's Land; but not being absolutely certain I prefer not to have them marked on the map. The fine weather allows us to take

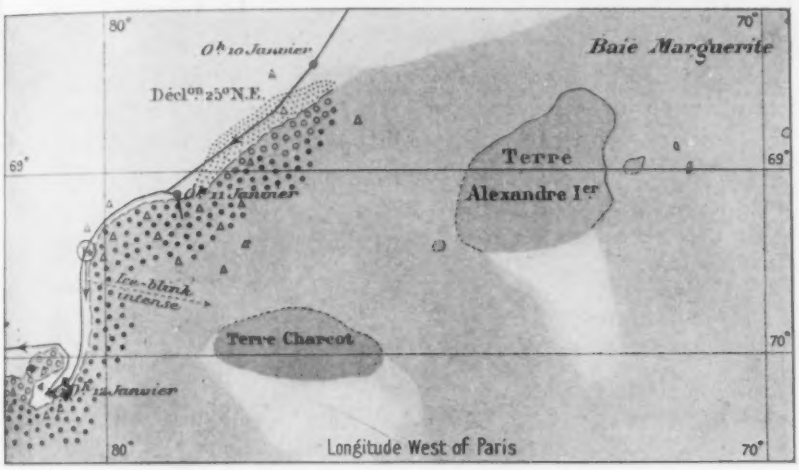


FIG. 3—The discovery of Charcot Land on January 11, 1910. From Carte d'itinéraire de la campagne d'été de 1910, Deuxième Expédition Antarctique Française (1908–1910).

observations and to place our discovery in longitude 74° 50′ and latitude 70° S. We have little chance of being able to reach this land, but I cannot resist the temptation of trying to approach it, and we hurl ourselves into the pack ice, using sail and steam, once more forgetting the injury to our bows.

Obliged to turn back, with some difficulty we finally succeeded in getting out of the dense pack and continued to follow the edge of the ice while the mist hid our discovery. The next day we were south of latitude 70°, but the wind was once more northeast with snow squalls and fog, and we had to content ourselves with an ice blink in the direction of our new land (Fig. 3). Whilst running over my private log to copy these quotations, I came across a forgotten sketch which I had penciled from the mizzen top on that day of January, 1910. Some details are so similar to what can be seen on one of Wilkins' photographs (his Fig. 20) that I include here a copy of it (Fig. 1).

Continuing on our route to longitude 125° W., we saw no other land than Peter I Island; Wilkins, notwithstanding his fourth flight to the south over the pack ice, fared no better, for lack of a few hours of fine weather. Nevertheless the total of his season's work is more than satisfactory for the most ambitious.

The political aspect of the discoveries I shall not dwell on. Of course I should prefer that the lands we were the first to discover should belong to my country; but that is not my business. It is sufficient for me that French science has profited by the information, observations, documents, collections, etc., brought back by the expeditions I had the honor to command. The British have the merited reputation of "fair play," and I am confident they will acknowledge the efforts of my countrymen—work whose value, such as it is, is enhanced by the confirmation and appreciation of one of the ablest sons of a nation that has played so magnificent a part in polar exploration.

Wilkins has appropriately enough proposed the names of Byrd and Mawson for two capes of Charcot Island; both are famous polar explorers and friends of France; but I should be very grateful if, after having pointed out these notable landmarks, he would be kind enough to hand me back my rights on this island for a few minutes so that I might name the other conspicuous points "Wilkins" and "Cheesman."

The Submarine in Polar Exploration

Sir Hubert Wilkins discusses the means of establishing and maintaining a meteorological base on the land seen or suspected to exist south of latitude 70° in this unkind Antarctic region. He considers that no surface ship, no matter how strong, could push through this ice; he shows the difficulties rendering very hazardous the use of airplanes; and arrives at the rather unexpected conclusion that the problem could be met more easily by using a specially built submarine.

Before starting on such an adventure it seems appropriate to read over again in "Twenty Thousand Leagues Under the Sea" the voyage of the *Nautilus* to the South Pole.[8] If this forecast, like others advanced by the author, becomes a reality, it will be only fair that the first land thus discovered should receive another French name—Jules Verne.

When Byrd was starting on his flight to the South Pole did he not exclaim, "It is Jules Verne who takes me there"? Simon Lake, the famous submarine architect who confesses that he always takes the *Nautilus* as a model, ends his book, "Submarine in War and Peace," by saying, "The fantasy of Jules Verne is the fact of today." *Ainsi soit il.*

[8] It is interesting *en passant* to note that Jules Verne during this polar voyage of the *Nautilus* also predicted the actual ice breakers. "Twenty Thousand Leagues Under the Sea" was written in 1870; the first project of an ice breaker was put forward by Britnefi, owner of a tug at Hamburg about forty years ago; and Admiral Makaroff built his famous *Ermak* in 1893.

EXPLORATIONS IN FOXE PENINSULA AND ALONG THE WEST COAST OF BAFFIN ISLAND*

J. Dewey Soper

THE Foxe Peninsula, long referred to as Foxe Land, comprises the entire southwestern extremity of Baffin Island. Into this area the author proceeded under instructions from the North West Territories and Yukon Branch, Department of the Interior, Canada, in July, 1928, to inquire into Eskimo conditions and the wild life of the region and to conduct exploratory surveys on the coast and in the interior.[1] Headquarters were taken up at the Cape Dorset post of the Hudson's Bay Company. Investigations were carried on with the aid of the Eskimos alone, whose faithful and untiring assistance, especially during winter travel, is quite indispensable to the Arctic explorer. The coastal surveys, during summer and fall, were conducted with the assistance of two natives, but on winter journeys of great length as many as four and five drivers were employed, when transportation difficulties demanded the use of 50 to 60 sledge dogs.

Up to this time the coast of Foxe Peninsula had never been surveyed in detail—except in limited sections—from Cape Dorchester to Chorkbak Inlet, while no white man had traveled widely through the heart of the interior from sea to sea. This extensive terrain—some 7200 square miles—was almost unknown except to a few Eskimos. It was found to contain many fair-sized lakes, rivers, and granite ranges of great interest. During the course of the work a chain of lakes north of Andrew Gordon Bay was explored and mapped, together with a river that flows from the northernmost of these, beyond the height of land, in a northwesterly direction to Foxe Basin. This provides a canoe route across the interior from sea to sea—the only one available in the peninsula.

Previous Explorations

Previous explorations in this region are few. Though the history of the Canadian Arctic opens with the first voyage of Sir Martin

*Published by permission of the North West Territories and Yukon Branch, Department of the Interior, Canada.

[1]Collateral work was undertaken for the Topographical Survey Department of the Interior, in magnetic declination; for the Department of Mines, in the collection of fossils and rock specimens; and for the National Herbarium and the Entomological Branch, Department of Agriculture, in the collection of plants and insects. Many meteorological data were gathered for the Meteorological Service of Canada; and the extensive and highly valuable collections of Baffin Island birds and their eggs and of mammals, made during the year, were turned over to the National Museum of Canada.

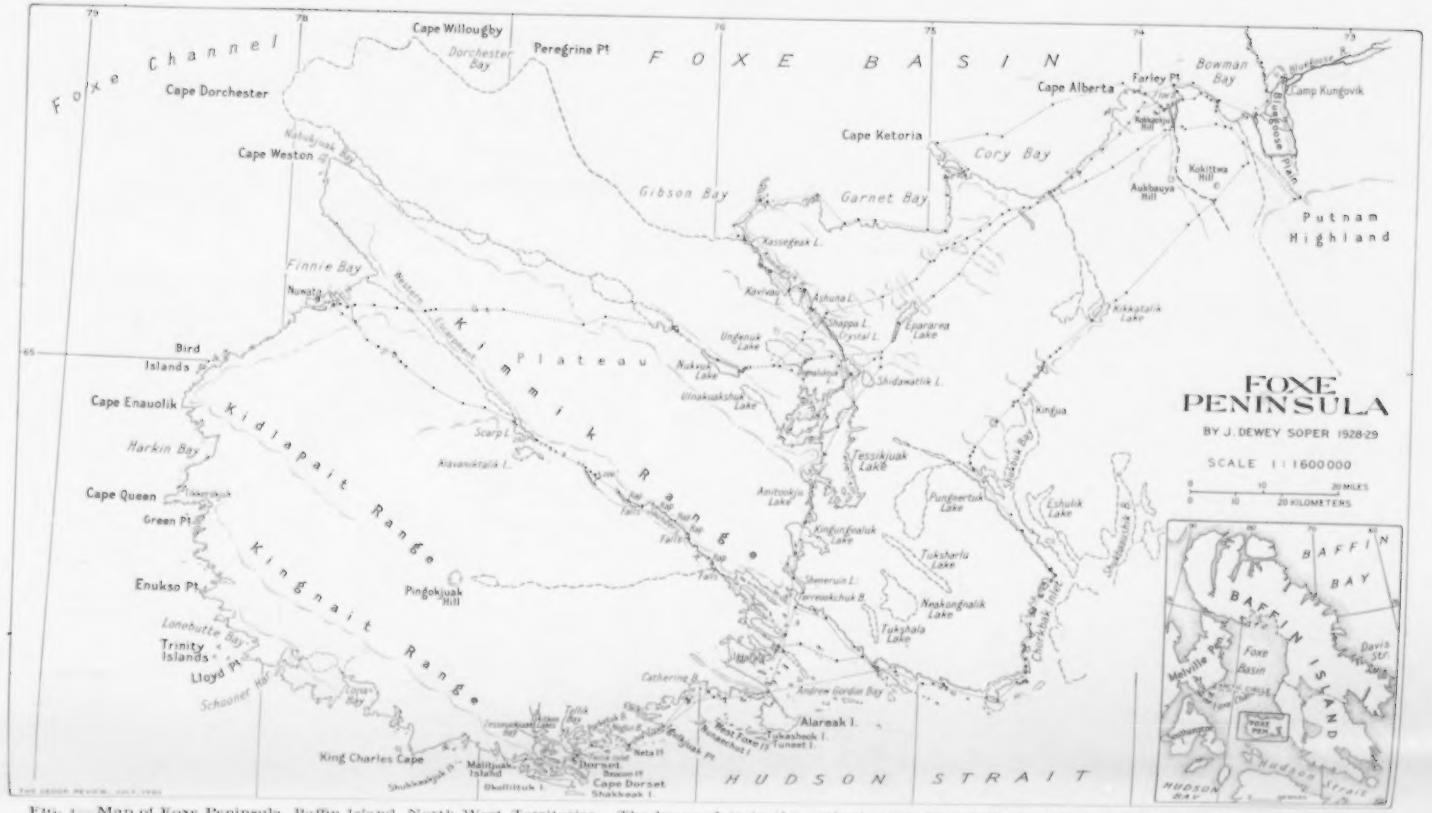


FIG. 1.—Map of Foxe Peninsula, Baffin Island, North West Territories. The heavy dots in the author's route lines indicate a change of bearing in the track survey and an observation station.

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Frobisher in 1576, Baffin was the first to sight the southern coast of Foxe Land in the year 1615, when he sailed north of Mill Island on his way to the north shore of Southampton Island. In 1631 Luke Foxe sailed along the west coast of Foxe Land, naming the prominent points, Cape Dorset, King Charles Promontory, Cape Queen, Lord Weston's Portland, and Point Peregrine, the last being the most northerly point reached. Sir W. E. Parry in 1821 in command of the *Hecla* and *Fury* sailed up Hudson Strait and Foxe Channel. Commander Gordon, after whom Andrew Gordon Bay was named, navigated Hudson Strait off the southwest coast of Baffin Island in the *Neptune*, 1884, and again sailed through the strait in the *Alert*, 1885–1886. The *Bowdoin*, commanded by Donald B. MacMillan, wintered at Schooner Harbour (77° 52′ W., 64° 24′ N.) in 1921–1922, while Mr. G. D. Howell, making magnetic observations for the Carnegie Institution of Washington, traveled eastward to a point 75° 44′ W.[2] In 1924, Major L. T. Burwash, North West Territories and Yukon Branch, Department of the Interior, Canada, made a rapid reconnaissance survey of the coast from Andrew Gordon Bay to Cape Queen. Lastly, the Putnam Baffin Island Expedition explored and mapped the north coast of Foxe Land during the summer of 1927.[3]

The exploratory work carried on by the writer in Baffin Island during 1928–1929, aggregating a traveled distance of 2300 miles, was divided into five major journeys which will be taken up in sequence.

Cape Dorset Region

During August, 1928, a survey was made from Cape Dorset to the Putnam expedition's cairn on Cape Dorchester.

Maps, even of recent date, indicate Cape Dorset as a long, narrow peninsula. In reality it consists of several islands. The easternmost and largest is Dorset Island, on which the Hudson's Bay Company post is established. The next largest is that to the northwest, Malitjuak, beyond which are three smaller islands lying between it and the mainland. The five islands are all connected by tidal bars at the phase of lowest water. In the geologically recent past all the channels about the cape were deep at all times, but recent land emergence has created the present obstructions represented by the tidal bars. Four other islands to the south and a hooklike projection of the mainland to the west form the general land mass of Cape Dorset. The question arises, naturally, whether the name Cape Dorset should be applied to the southern extremity of Dorset Island—the largest and most

[2] See *Geogr. Rev.*, Vol. 18, 1928, p. 351.

[3] George Palmer Putnam: The Putnam Baffin Island Expedition, *Geogr. Rev.*, Vol. 18, 1928, pp. 1–40.

prominent of the group—or to the eastern end of Shakkeak Island, which occupies the southernmost position.

The group is flanked by two main inlets, or channels, which converge and terminate in a large bay known to the Eskimos as Tesseuokjuak. Tellik, the easternmost inlet, is obstructed at the narrows entering Tesseuokjuak by a tidal bar. In addition there

FIG. 2—Hudson's Bay Company post at Cape Dorset; author's snow house observatory in the right foreground.

are several dangerous reefs and shoals, principally westward of the entrance to Dorset harbor.

No one feature is more characteristic of the region than the intricacy of its coast lines, together with the profusion of its coastal islands. A large number of these have, geologically speaking, been created by the land emergence of recent times. The bewilderingly complicated coast line continues predominant to the eastward: it typifies the whole thousand-mile seaboard on the south and east sides of Baffin Island.

Above all, the Dorset region is characterized by its high lands, high as compared with the territories to the east, west, and north. It is known to the Eskimos as Kingnait, "land of the high hills." The ranges lack grandeur as contrasted with the mountain masses of eastern Baffin Island, but they are nevertheless imposing. The outstanding portion is that upon Dorset and Malitjuak islands, with an extension beyond West Inlet and the head of Tesseuokjuak Bay. This, the Kingnait Range, reaches an average elevation of about 750 feet above sea level, with conspicuous points attaining to 800 or 850 feet. It is especially notable from the coast and islands to the east, from which points the rugged granitic masses loom up against

the sky as veritable mountains; they are still prominent and eye-arresting at a distance of thirty or forty miles.

To the north of Dorset a long high coastal range with a similar west-northwest trend has an average height of about 800 feet, with isolated, rounded domes reaching a probable height of slightly under 1000 feet. It is peculiar in having a long band of coarsely crystalline

FIG. 3—Camp at Nuwata, west coast of Foxe Peninsula.

limestone extending along its seaward face, which continues, brokenly, past Amadjuak Bay as far, at least, as Lake Harbour, where it outcrops in several bands between 200 and 300 feet thick.[4]

This range is rolling, with a gradual slope to the east and north; in the latter direction it merges into the lowlands of northern Foxe Land slightly beyond the 65th parallel of latitude. At a point not over ten miles east of Dorset it falls off to half the height, while at Andrew Gordon Bay the hills are comparatively insignificant with elevations of only 100 to 400 feet. The major heights are maintained for a somewhat greater distance to the westward of Cape Dorset, but at Schooner Harbour, 41 miles in an air line from Dorset, they do not exceed 300 or 400 feet in height. Regardless of proportion, the hills retain a certain changeless and savage ruggedness. As in all mountainous regions of such extremes of temperature, talus slopes feature commonly in the topography. In certain situations, under high cliffs of finely fractured crystallines, they reach gigantic proportions.

Glaciation has operated here, as in many other regions of Baffin Island, with great intensity. Transported boulders, however, are not so numerous as in some regions, as for instance about Nettilling

[4] L. J. Weeks: Cumberland Sound Area, Baffin Island, *Canada Geol. Survey Summary Rept.*, 1927, pp. 83C–95C; reference on p. 95C.

Lake and Nettilling Fiord, Cumberland Sound. Glacial markings on the crest of the Kingnait Range at 800 feet take a direction between 5° and 10° east of north.

Old raised beaches, or terraces, are exceedingly common. The Hudson's Bay Company post here is built upon a former beach at about 25 feet above present sea level, and across the bay a fine example is to be noted at 65 feet.[5] To the south of the post raised terraces occur on the slope of the Kingnait Range to an elevation of at least 300 feet. Scores are in a wonderful state of preservation, composed of clean, well washed gravel with nearly the freshness of newly made strand lines, and free alike from that tarnishing noted on long exposed rock, and the lichens, moss, and other vegetation which carpet the rocks of higher levels. These fresh-appearing terraces occupy slopes, mouths of valleys and saddles between the hills up to at least 150 feet above sea level. They frequently take on graceful, curved lines, one surmounting the other on gentle and sheltered valley inclines.

West Coast of Foxe Peninsula

About thirteen miles west of Dorset the congestion of islands particularly notable in this area practically disappears; and the traveler, on emerging from the inside passage, gains his first real view of the open sea. The coast northwesterly to Schooner Harbour is indented by numerous bays, some of which are generously proportioned, with a few small islands off shore. In general, the coastal region continues rugged and scenic but is already considerably lower than the highlands near Cape Dorset. An average elevation of 400 to 500 feet obtains, though higher ridges of the northwesterly-trending Kingnait Range appear inland at no great distance. On the whole, the territory presents a forlorn and dreary appearance, with an almost complete absence of vegetation. Here and there a wisp of green in secluded valleys tends to relieve the dead monotony.

Schooner Harbour is unique in being practically landlocked and is the only bay of its kind on the west coast affording good anchorage for small vessels. It is roughly oval in outline, a mile and a half wide and two and a half miles long. The entrance is divided by a large island, which creates two passages, both narrow though deep. Several islands fleck the bay; and a rushing river enters it from the northeast, which the Eskimos say drains a large lake called Tessealuk-juak. The topography continues rugged in relief, though seldom do heights exceed 300 to 350 feet. The deep valleys, cliffs, bold granite ridges, and buttes impart an impression at first of greater elevation. Talus and glacial boulders add to the wild configuration of the land. In some of the valleys is a relatively considerable soil accumulation

[5] Putnam, *op. cit.*, p. 33, Figures 30 and 31.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Looking south down Amitookju Lake from the portage into Tessikjuak Lake.
FIG. 5—Portaging at the rapids on the Amitookju River.
FIG. 6—View of the Moukjunil River, showing the low character of the region.

on which the usual stunted Arctic vegetation flourishes to no mean extent. The Eskimo term for Schooner Harbour is Ejoyetuk, "a place where peaty soil has accumulated." On the north side of the bay are meadow-like flats carpeted with low herbage.

Eight miles to the west lie the Trinity Islands, named by Foxe in 1631, consisting of five instead of three islands as formerly supposed.

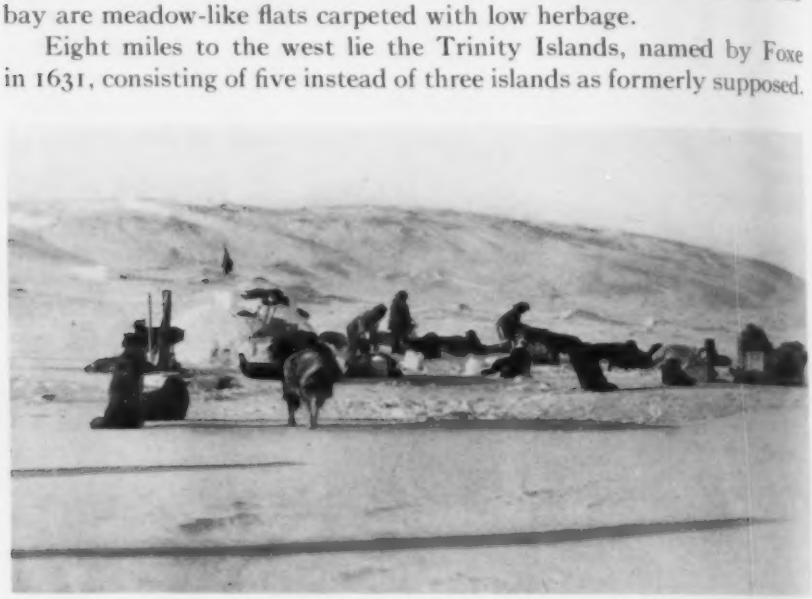

FIG. 7—Breaking camp at Depot 2, near Bowman Bay, Foxe Basin.

Then follows to the north-northwest, for a distance of 24 miles, an intricate coast line of numerous small bays and points of varying size, which terminates at Cape Queen—the westernmost point on the coast (approximately 78° 31′ W.). The intervening coastal hills, of the usual Pre-Cambrian granites and gneisses, are relatively low, with elevations of 25 to 80 or 90 feet. Inland a short distance is a paralleling ridge of bolder relief, which terminates in a bluff at Cape Queen with a height of about 150 feet and constitutes the western extremity of the Kingnait Range. In comparison with the coastal areas, both north and south, which are generally low, it stands forth boldly to attract the attention of navigators making a coastwise passage. Foxe seems to have hit upon the latitude of Cape Queen with fair accuracy, in contradistinction to his disposition of Cape Dorchester. On his sketch map of 1924, Major L. T. Burwash indicates Cape Queen as "Land's End," signifying the westernmost extension of Foxe Peninsula. The Eskimos call it Tikkerokjuk, meaning "to visit at a rendezvous."

Fourteen miles north is Cape Enauolik, the westerly end of the Kidlapait Range, which trends in a southeasterly direction far into the heart of Foxe Land. An ancient rendezvous of the Eskimos, called Enauolik, is situated at the very extremity of the cape.

For several miles to the south of this point the coast is tortuously indented by numerous small bays, from which the sea withdraws at low tide leaving dreary wastes of unpleasantly odorous mud and tidal pools. Here, indeed, is the first hint of the singular condition that becomes so characteristic of the shores to the north on Foxe Basin where vast mud flats are exposed at low tide. Fleets of small

FIG. 8—A halt at the mouth of the Hantzsch River in latitude 67° 33′ 31″ N.

islands point further to the shallow nature of the sea in this locality.

The slightly higher granites that reach the sea at Cape Enauolik recede rapidly from the coast in an east-northeast direction to leave a bordering lowland that extends six miles inland from the native village of Nuwata in 65° 8′ N. This plain is low and swampy with numerous streams and ponds—a favorite breeding place of numerous species of waterfowl and small waders. Much of it is no more than 10 to 20 feet above sea level, with low granite outcrops rising from the grassy swamps to the height of another 10 to 30 feet.

Thirty-three miles distant by air line is Cape Weston (Eskimo, Nubukjuaushik), determined, like capes Enauolik and Queen, by the westerly end of a low massive rib of hills. In this instance it is the Kimmik Range, which extends unbrokenly in a northeasterly direction across Foxe Land from Andrew Gordon Bay to Foxe Channel. Near the base of the cape it rises steeply in the vicinity of the sea to elevations of 75 to 150 feet, but a few miles to the northwest it declines into a low and almost featureless land of swampy meadows, ponds, streams, and low rocky hummocks.

Exceedingly fine examples of raised beaches figure in the locality. Near the end of Finnie Bay many were noted on the side of the Weston escarpment at varying elevations of from 20 to about 60 feet above

sea level. Along the south and west coasts of the cape such gravel terraces are numerous and well preserved, the larger number occurring at an elevation of about 20 feet. Those at the lower levels have a fresh and undisturbed appearance.

Another extremity of the Kimmik Range reaches the sea as Cape Dorchester (Nabukjuak), desolate hills of granite and gneiss only 50 or 60 feet high. Between the Kimmik Range and Foxe Basin, 20 miles distant, is a lowland sprinkled with numerous lakes and intersected by low granite ridges which reflect again the interesting geological structure of Foxe Peninsula, in which all the major ridges run parallel to one another on an approximate trend of north 50° west.

Coast Region between Cape Dorset and Chorkbak Inlet

In September, 1928, a survey was made of the coast from Cape Dorset east to the head of Andrew Gordon Bay and northward into the interior. It is safe to say that the confounding complication of the coast from a point east of Chorkbak Inlet to Cape Dorset was not formerly suspected by visiting whites. Even a recent survey of Chorkbak Inlet—the only locality on the south coast of Foxe Peninsula previously to receive any close attention—is faulty, owing to the unsuspected presence of a large additional arm to the northeast (Shukbaaushik), which is disguised by many large interlocking islands erroneously believed to constitute at once the mainland and the east coast of the inlet.

The coast between Chorkbak Inlet and the head of Andrew Gordon Bay, at Terreookchuk—a distance of 32 miles—is comparatively simple, though a large number of islands flank it rather closely. The neighboring granites and gneisses are generally of rugged relief, with elevations up to 300 and 400 feet.

The west shore of Andrew Gordon Bay is divided into two major indentations, the northernmost of which is so masked by a mass of islands as to cause its existence to be quite unsuspected by a traveler passing up the bay from Alareak Narrows to Terreookchuk. It has a trend to the northwest coincident with the adjacent Kimmik Range.

The southwestern portion of Andrew Gordon Bay forms a deep elongation to the northwest, eight miles long and between four and five miles wide and parallel to the northern half. It is more open than the latter but still lavishly furnished with small, rocky islands. On the north shore is a nearly landlocked embayment, joined to the sea at higher stages of the tide by a narrow passage. Owing to difference of level and the constricted entrance, magnificent rapids and cascades are developed by the alternating high and low phases of the tide. The thunderous roar of the reversing falls can be heard over a distance of several miles. Strong tide rips are characteristic of the bay, the

most powerful of which is developed at the narrow entrance to Terreookchuk. The narrow passages that separate Alareak Island from the mainland also are the scene of veritable maelstroms at the turn of the tide, with plunging currents, vortices, and rips of prodigious power and activity.

That this part of the coast is still in process of emergence is indicated by the numerous freshly raised terraces, by the gradual creation

Portages (Yards)		Lakes	Length (Miles)	Approx. Elevation (Feet)
West of river	115	Shenoktik	1.6	20
East of river	270	Hare	.4	75
East of river	50	Cairn Hill	.8	85
East of river	120	Cascade	.3	87
West of river	155	Portage	.3	105
West of river	110	Sheneruin	5.2	110
.....		Kingungealuk	6.1	110
(Height of land)	350	Amitookju	5.8	130
West of river	20	Tessikjuak	17.0	125
East of river	800	Ungmaluktuk	3.5	115
East of river	4,050	Crystal	2.3	110
West of river	30	Gale	1.2	109
East of west branch	80	Shappa	2.3	103
East of river	40	Ashuna	2.6	102
.....		Kavivau	6.0	101
.....		Kassegeak	1.4	15

of bars between mainland and islands, and by vestigial salt-water lakes at various points along the coasts. It is also supported by the fact that since time immemorial the Eskimos have used the narrow passages described above as convenient "short-cut" boat routes when sailing east or west, by means of which they avoid the long twelve-to-fourteen-mile detour necessitated in rounding Alareak Island. Today they assert that the passages are becoming consistently more difficult and that the "lowering of the ocean" has made useless, within the memory of the older generation, certain narrows once freely employed.

Interior North of Andrew Gordon Bay

Terreookchuk gives access to the only canoe route across Foxe Peninsula. It extends by a chain of sixteen lakes and the Kommanik River to Foxe Basin. The lakes and the portages en route from Terreookchuk are as shown above.

Several additional short portages are required between Kavivau and Kassegeak lakes, owing both to the turbulent and, in places,

shallow nature of the stream. The total length of the route is 55 miles, of which about 3.6 miles are portages.

The country surrounding Terreookchuk is comparatively low, with hills of Pre-Cambrian crystallines seldom exceeding 200 feet; the general relief, though in detail rugged, is characterized by a certain monotonous uniformity. The region is especially typified by its extensive system of lakes. Everywhere the rocks have been scoured and reduced by intense glacial action, which operated from north 4° east and whose effects still show with surprising distinctness. Glacial erratics are scattered in great profusion: they are far more numerous here than on the higher terrain about Cape Dorset. On the whole the rocks are absolutely bare, as though but recently scoured clean of every vestige of overlying soil. In depressions about pools and lakes, however, is a scanty soil mantle which supports a meager growth of mosses, lichens, white heather, crowberry, miniature scattered willows, and other plants.

The height of land between Hudson Strait and Foxe Basin occurs between Kingungealuk and Amitookju lakes, represented by a portage 350 yards long. The land rises only 10 to 25 feet above lake level, where an old Eskimo trail is still plainly visible. On the rocky, northern end the boulders have all been rolled aside over a roadway six feet wide to permit the portaging of boats from lake to lake.

Amitookju, with its narrow, winding length of nearly six miles, north and south, is more like a river than a lake. The surrounding terrain is generally low and rolling, with occasional pronounced ridges of barren rock that impinge upon both east and west shores. The scenery is quite unimpressive and becomes even more dreary and monotonous to the north.

It is understood from the Eskimos that Tessikjuak is the largest of the many lakes of Foxe Peninsula. It is 17 miles long, north and south, with a maximum width at each end of about 9 miles. The whole lake is characterized by a tortuously indented shore line, with flanking granite ridges rising above the water in places from 150 to 200 feet. In the northern part these attain heights of only 25 to 40 feet. Beyond Tessikjuak, to the north, lies a great marshland, bounded on the horizon by a ridge which the Eskimos say parallels the Kommanik River and terminates near its mouth at Foxe Basin. Over this far-flung, melancholy land are innumerable ponds, lakes, and low, northwesterly-trending granitic ridges, which go to make up the extensive lowlands of northern Foxe Land.

Dwarf vegetation scantily carpets most of the country. Several species of moss are most in evidence; and the rocks, as always, appear somber in a thin veneer of dark lichens. The scarcity of higher plants in general and the marked impoverishment of all are characteristic of the northern interior.

There can be no question that this lowland region, south through the area of depression occupied by the chain of lakes to Andrew Gordon Bay, has been submerged by the sea in recent geological times. An interesting feature of the locality about the Kungguk Narrows, in Tessikjuak Lake, is the abundance of well preserved mollusk shells imbedded in the glacial, or reworked marine clay, which figures in beds alongshore and at higher levels.

This submergence was doubtless coeval with the inundation of the great tundra of western Baffin Island and the Nettilling Lake region, where similar marine beaches with shells as at Kungguk were observed by the writer in 1925 at the south end of Nettilling Lake between 110 and 135 feet above present sea level. The Kungguk shells were found in clay-filled depressions and in terraces up to 20 feet above lake level, or about 145 feet above sea level. This is strikingly in agreement with observed conditions at Nettilling Lake. The writer considers the submergence and the succeeding uplift synchronous throughout the whole southwestern portion of Baffin Island, without necessarily implying an exactly similar rate of emergence. The whole of Foxe Peninsula has risen in late geologic times with relative rapidity; but the process appears at present to be more active along the northern border of the area, as demonstrated by the gravel terraces there, whose clean, subangular materials are of astonishing freshness.

The survey was terminated in the fall of 1928 at a cairn on the east bank of the Moukjunil River in 64° 58′ 30″ N., approximately 75° 22′ W. Subsequently, in the summer of 1929, a survey was carried up the Kommanik River from Foxe Basin to Ungmaluktuk Lake and tied in at the Moukjunil cairn.

Ungmaluktuk Lake, with an elevation of about 115 feet above sea level, is three and a half miles long—northwest-southeast—and slightly over a mile wide. The Kommanik River discharges at its northwestern extremity, to follow a general course of north 40° west for 22 miles to Foxe Basin. It passes through a series of six lakes with an aggregate length of 14 miles. Thus, of the 22 miles total length only 8 miles of river course is represented, which is consistently difficult of navigation. The 6 miles below Kavivau Lake, to Foxe Basin, is practically a continuous series of rapids, with a total fall of about 100 feet. The adjoining country is composed of marshy flats, intersected by rocky ridges trending northwest-southeast.

Traverse of the Foxe Land Interior

On January 16, 1929, a traverse to Nuwata was begun from Andrew Gordon Bay. At the northwestern extremity a large river discharges, named Saunders River by the author in the absence of a native name. A noon position one mile up the river gave a latitude

of 64° 36′ N. The main northern branch was mapped northwesterly for a distance of 20 miles to its source in a small lake of the interior plateau country at an elevation of about 140 feet above the sea. Its course is marked throughout by numerous rapids, cascades, and falls. A few miles from the mouth the main stream branches off to the west

FIG. 9—Terrain of Pre-Cambrian crystallines, with boulder "drift," on the Foxe Basin coast in latitude 67° 25′ N.

and heads in a lake far to the southwest near the conspicuous hill Pingokjuak.

From the head of Saunders River a course was taken directly overland to the northwest, where we entered upon a plateau with an average elevation of 350 feet above sea level. Except for an occasional Eskimo hunter this particular territory is unfrequented and, furthermore, was found practically destitute of game. Traveling conditions were good on a wind-packed surface of snow over a terrain of low relief which undulated easily in long, open valleys to the distant horizon. There is scarcely any obstruction to travel or a hill sufficiently large to create a marked impression. This came as a surprise, as the area is removed but 40 miles from the rugged coasts to the south with elevations up to nearly 1000 feet. With clear weather higher land was occasionally glimpsed to the south and southeast.

Many small lakes were passed en route and two larger ones near the height of land, 33 miles in an air line northwest of Andrew Gordon Bay. The more northerly one—Scarp Lake—which was crossed, is four miles long with its main axis northwest-southeast, in conformity with the trend of all the main granitic masses of the country. An observation gave latitude 64° 54′ N. for its northwestern extremity. It is the source of a river which flows along the base of the Weston escarpment and discharges into Finnie Bay.

The Weston escarpment becomes visible in its true nature immediately west of Scarp Lake, which represents the southern wall of an ancient plateau or peneplain that persists for 33 miles northwesterly to Cape Weston. Its elevation above sea level is 375 feet. From the height of land at Scarp Lake the descent is gradual on easy

FIG. 10—Northern extremity of the limestone highlands in latitude 67° 31′ N., on the Hantzsch River near the west coast of Baffin Island.

slopes and across long bench lands and monotonous lowlands to Nuwata, which was reached on January 20.

Additional dog feed was obtained from the Nuwata Eskimos, and the traverse to Tessikjuak lake was begun on the morning of January 22. The lowland was crossed for a distance of 15 miles on a bearing of north 40° east, magnetic, to the base of the escarpment, where a suitable ravine was found by which an ascent was made to the summit. All along the scarp at this point magnificent examples of raised beaches were observed in a fine state of preservation up to elevations of 250 feet.

The top of the plateau is of low relief with a gentle declivity to the north. Seldom does the surface exhibit greater irregularities than 10 to 15 feet, and much of it is flatter with gently-fashioned undulations which are maintained with little change for long distances.

Unfortunately, rough weather with blinding drift broke upon the party almost as soon as the top of the plateau was reached, and this continued uninterruptedly for two days with the poorest of visibility. Enough was ascertained, however, to give a sound knowledge of the topography and to piece out, with later correlation, the nature and extent of the leading physical features of this portion of the Foxe Land interior. The chief of these is the universal northwest-southeast

strike of the Pre-Cambrian ridges and low plateaus, which cover the entire region from Hudson Strait to Foxe Basin. Most of the lakes and the principal bays on the coast reflect the same tendency.

A distance of 22 miles on an easterly course across the plateau brought us to its northern margin at a height of about 275 feet, where a rather abrupt drop of 75 feet occurred. Old marine benches were again encountered at this point near the rim at an apparent elevation, by aneroid, of 250 or 260 feet, which agreed with the height of the uppermost noted on the southern escarpment.

From the top of the plateau, at the northern rim, the country below appears almost flat over the 16 miles of lowland to Foxe Basin, but it evidently has a gradual slope to the sea of about 12 feet to the mile. Occasional granite ridges intersect this lowland, rising above it from 20 to 70 or 80 feet. Eight principal lakes occur here, disregarding the lake chain to the east, of which Tessikjuak is a member. Three of these were crossed on the traverse—the first nameless, the other two known to the Eskimos as Nukvuk and Ungenuk respectively.

The Moukjunil River was reached on January 25, where the survey was tied in at the cairn on the east bank, the position of which was previously established in the fall of 1928. On the morning of the 27th a start was made south over Tessikjuak Lake in the finest of winter weather, and camp was made that night at Sheneruin Lake, 25 miles distant. The next night was spent at Catherine Bay, Hudson Strait, 26 miles from Sheneruin and 21 from Dorset post. The latter was reached the following afternoon, January 29, after an absence of 20 days.

Incidental to the return, a "check-line" survey was carried throughout from the north end of Tessikjuak Lake to Dorset, a distance of 72 miles. A knowledge of the region on this occasion facilitated direct courses and long range bearings, contributing greatly to accuracy of results, which would have been impossible to one unfamiliar with the route and topography.

Cape Dorset to Hantzsch River

During the months of March and April, 1929, a journey of exploration was undertaken from Cape Dorset to Hantzsch River, in latitude 67° 34′ N., through territory much of which was previously unobserved by a white man. As the country is practically gameless in winter, elaborate preparations were required in estimating the necessary provisions, fuel, and dog feed, together with the disposition of widely spaced depots of supplies from which men and dog teams were successively to be turned back at appointed times.

The writer left Dorset harbor on March 11, accompanied by five Eskimo drivers and sledges and an equal number of teams composed

of 56 dogs. As the expedition was obliged to be entirely self-supporting for the entire duration of the journey of over 800 miles, the loads in consequence were heavy, with an aggregate weight of 4158 pounds.

Catherine Bay to the east was reached the first night out, Sheneruin Lake on the evening of the 12th, and Kungguk Narrows, Tessikjuak Lake, on the 13th, where Depot No. 1 was established. The route had formerly been surveyed to this point and beyond to the Moukjunil River in latitude 64° 58′ 30″ N. The following three days were spent in running a traverse across the interior to Bowman Bay, where Depot No. 2 was established in latitude 64° 29′ N. The intervening country is a portion of an old glacial plateau, characterized by rolling plains interspersed with low hills and ridges of Pre-Cambrian crystallines.

On March 17 one man was returned from Depot No. 2, while the main party continued along the Foxe Basin coast to the northwest. The region comprises a vast, flat plain as far as eye can see, quite featureless except for widely distributed "islands" of low, rounded granites that protrude a few feet above the tundra, together with occasional erratics. The former entirely disappear from the plain in latitude 65° 45′, and over large areas even the boulders, leaving a flat plain unrelieved by a single feature. Far to the southeast, however, the mesa-like rampart of Putnam Highland rises boldly from the tundra, constituting the dominant physical feature of the entire region surrounding Bowman Bay.

The survey was carried along the margin of the broken floe ice which here tapers out on the tundra with a more or less distinct boundary; in places the old, dirty sea ice is raftered into coastwise ridges from 10 to 15 feet in height. By noon of March 19 the party had reached a point where the coast, after persisting in a northwesterly direction for 49 miles, inclined to the north and northeast. From this point, 66° 12′ 30″ N., approximately 74° 28′ W., the coast swings abruptly to the northeast on a general bearing of north 38° east, and continues thus in almost a straight line for a distance of 78 miles to the south shore of Taverner Bay in 67° 7′ N. The deflection of the coast in 66° 12′ N. forms a cape of large extent which has been named Cape Dominion. The existence of this was formerly unknown, except by assumption, based upon my provisional placement of the west coast near the Koukdjuak River in 1926.[6]

Depot No. 3 was established on the night of March 19 in latitude 66° 16′ 30″ by account, from which point the second man of the supporting party was turned back the following morning for Cape Dorset, now distant 210 miles. The south shore of the Koukdjuak River was reached in late afternoon of the 21st. On the return journey

[6] J. Dewey Soper: A Faunal Investigation of Southern Baffin Island, *Natl. Museum of Canada Bull. No. 53 (Biol. Ser. No. 15)*, 1928. This contains a short account of the writer's explorations of 1924, 1925, and 1926. And see "Explorations in Baffin Island," *Geogr. Journ.*, Vol. 75, 1930, pp. 435–443.

the latitude of this place was determined as 66° 46′ 43″ N. Measurement of the mouth of this large river by sledge meter indicated a width of 2.1 statute miles. Depot No. 4 was made one mile north of the Koukdjuak on the plain near the sea.

The last two natives of the supporting party were turned back on March 24 from a camp made on the south shore of Taverner Bay

FIG. 11—View of the top of the limestone plateau, with its mantle of granitic boulders, in latitude 67° 31′ N. Edge of the western escarpment to be seen in the distance on the right.

(67° 7′ 5″ N.), where a one-day halt was called to rest the dogs. From here, the writer with one native, Shappa, pushed on to the northward, more heavily loaded now than at any previous phase of the journey. In 67° 14′ N. the great western plain comes to an abrupt termination, a limestone scarp with a height of 10 to 15 feet reaching the coast at this point.

Immediately beyond this to the north the granites make their appearance again as low rugged areas interspersed with grassy plains of varying extent. The character of the country undergoes a complete transformation and, though the granites seldom exceed 15 to 20 feet in height, the region appears immoderately rough in the eyes of the traveler after a week of marching on the vast, featureless plains to the south. To the east, in latitude 67° 20′ N., the limestone highlands may be seen to rise along the distant horizon to heights of 150 or possibly 200 feet. On its western margin sheer scarps and bluffs and shadowed, stream-gouged ravines add character to the formation.

The rediscovery of the Hantzsch River—known to the Eskimos as Koukdjitariak—since its first location by Hantzsch in 1910[7] constituted one of the objectives of the expedition. It was therefore

[7] M. Rosenmüller: Bernhard Hantzsch und seine letzte Forschungsreise in Baffinland, *Mitt. Vereins für Erdkunde zu Dresden*, Vol. 2, 1913, pp. 669–716.

with satisfaction that on March 29 the stream was found and followed to its mouth, where a series of observations at noon gave a latitude of 67° 33′ 30″ N. The location of this on Hantzsch's map (1913) is approximately 67° 29′ 36″ N., an error of 3′ 54″, while his placement of the mouth of the Koukdjuak River is about 7′ 28″ too far south.

A search was made about the mouth of the Hantzsch River for

FIG. 12—The west coast of Bowman Bay in latitude 65° 33′ N.

evidence of his winter quarters, which are known to have been near by, but no sign of them could be discovered; nor did he leave a cairn of any description that could be found to mark his visit here. The tragic fate of Hantzsch, the only white man to precede the writer to this lonely region, remains one of the most regrettable episodes in the annals of Baffin Island history. It was a matter of disappointment that his grave, which is situated about 12 miles north of the river bearing his name, could not be visited owing to lack of time and dog feed.

The ascent of the river was begun on the afternoon of the 29th, and a survey of it was made to a point 38.9 miles inland in 67° 31′ N. at an elevation of about 80 feet above sea level. This stream in all probability drains the large lake, Tesseokjuak, reported by the Cumberland Sound Eskimos as occupying the region north of Nettilling Lake, as yet unvisited by any white man. It had been hoped that sufficient dog feed could be secured to permit exploration to this point; but such was not the case.

To the north of the Hantzsch River the terrain is composed of rugged, glaciated granite ridges rising to a height of about 300 feet above sea level, while to the south is the limestone highland, which at the point referred to above ends in an abrupt escarpment near the

river, about 120 feet high, or approximately 200 feet above sea level. The top of the plateau supports a large number of erratic, granite boulders, some of large size, which undoubtedly were derived from the Pre-Cambrian area to the north and released here on the withdrawal of the ice sheet that once covered a large part of Baffin Island.

The eastern border of these sedimentary strata describes an irregular line on a general trend of south-southeast and appears at the very northern extremity of Nettilling Lake at Karmang.

After the limestone scarp had been skirted and mapped to its point of contact with Foxe Basin in 67° 16′ N., the coast was retraced to Bowman Bay to recover cached supplies at the various depots.

With a small surplus of provisions in hand at Depot No. 2, a traverse was run on April 8 from Bowman Bay to the large, central canyon in Putnam Highland—a distance of 14.5 statute miles on a bearing of south 45° east. At this point the highland rises almost sheer from the flat tundra to a height of 450 feet, as ascertained by aneroid on the rim to the west of the large canyon; farther inland it rises on a gentle slope to an elevation of probably nearly 600 feet. Along the face of a portion of the escarpment, principally to the west of the canyon referred to, are two conspicuous benches, one at about 75 feet and the other at 175 feet.

At the time of the writer's visit to Putnam Highland the country was so deeply snow-mantled that many of the finer points of its structure could not be seen. Gould[8] observes, however, that the mesa profiles of the highland are due to the fact that the topmost 30 to 50 feet of the limestone composing them is considerably more resistant to weathering than the underlying strata, which are mainly a blue-gray, fissile, calcareous shale that weathers with extreme rapidity. Where exposed without the more resistant cover rock, the shale becomes gullied into a sort of miniature badland relief. Only recently the foot of the highland was washed by the Foxe Basin sea, the rapid cutting by the waves of the weaker shales below the harder cap rock apparently being an important factor in producing the sharp profile represented in the escarpment at this point. The same general condition obtains for the escarpment at the northern extremity of the formation between 67° 17′ and 67° 31′ N., though the horizontal beds rest upon the granites at a height of about 80 feet above sea level at the extreme northern end instead of nearly at sea level as at Putnam Highland. Where the formation borders the west shore of Amadjuak Lake it rises in places sheer as a wall, free of débris, to a height of about 70 feet.

[8] Laurence M. Gould: Report on the Physical Geography [of the Regions visited by] the Putnam Baffin Island Expedition, *Geogr. Rev.*, Vol. 18, 1928, pp. 27–40; reference on pp. 34–35. See also Laurence M. Gould, A. F. Foerste, and R. G. Hussey: Contributions to the Geology of Foxe Land, Baffin Island, *Contribs. from the Museum of Paleontology, Univ. of Michigan*, Vol. 3, No. 3, 1928, pp. 19–76; especially pp. 19–24.

FIG. 13

FIG. 14

FIG. 13—The large central canyon of Putnam Highland in latitude 65° 20′ N., as seen from the northern rim at an elevation of 450 feet.

FIG. 14—A deep ravine in the northern escarpment of Putnam Highland one mile southwest of the conspicuous canyon in latitude 65° 20′ N.

The flat-lying limestone and shales exhibit practically their entire thickness at Putnam Highland, as the near-by floor of Bowman Bay is composed of Pre-Cambrian rocks that outcrop in the tundra at intervals as low ridges nearly all the way to the base of the highland. The great flat tundra to the north is probably underlain by thin beds of limestone or shale which extend westwardly to disappear under the waters of Foxe Basin. In the region of Camp Kungovik clay mantles the country to a depth of at least 3 to 15 feet, but on Blue-goose River the limestone outcrops to form low banks in 65° 38′ N. Gould mentions that as far as they voyaged north on the west Baffin Island coast, that is to 66° 17′ N., the Putnam Highland formation is represented by only a few feet of shale. The writer in 1925 observed that the only limestone in place along the Koukdjuak River was found in the bed of the stream, where many fossils occurred, as well as on the banks of the river. Such beach fossils in broken shale and lime-stone are also numerous along the southwestern shore of Nettilling Lake, where they have been pushed up by ice pressure.[9]

A representative collection of fossils was made by the writer from Putnam Highland, with which the mixed shale and limestone strata are abundantly supplied.[10]

Continuation of the return journey was made along the south coast of Foxe Basin, via Camp Walcott (Putnam), to a point in 65° 21′ N., approximately 74° 30′ W., where it was left and a traverse was run to Ungenuk Lake, thence to Tessikjuak Lake, south to Andrew Gordon Bay, and west to Cape Dorset, which was reached after an absence of 35 days. The journey totaled a distance of 819 statute miles.

Expedition to the Bowman Bay Region

The writer's year of exploration in southwestern Baffin Island, 1928–1929, culminated in a three-months' trip to the Bowman Bay region at Foxe Basin, covering the period from mid-May to mid-August. The chief purpose of the expedition was to discover, if possible, the breeding grounds of the elusive blue goose (*Chen caerules-cens*) and to make a detailed study of its habitat and general habits; but geographical work was also pursued coincidently.

The departure was made from Cape Dorset for Bowman Bay on May 17 with four sledges, 42 dogs, and five Eskimos, sufficient food and general equipment being carried to sustain work for three months. Instead of the easier and previously-explored route via Andrew Gordon Bay and Tessikjuak Lake, a new one was chosen along the

[9] A large number of these were collected and later determined as referable to Ordovician and Silurian. See Soper, *op. cit.*, pp. 124–129.

[10] A good account of the fossils of this locality is given in Gould, Foerste, and Hussey, *op. cit.*, pp. 25–75.

south coast. A survey was conducted from Iggarashuk, where the coastal survey of the winter before had terminated, along the coast to Chorkbak Inlet, up its western shore to a point near the northwestern extremity at Terreuya Bay, and thence on a general course of north 42° east across the interior to Bowman Bay.

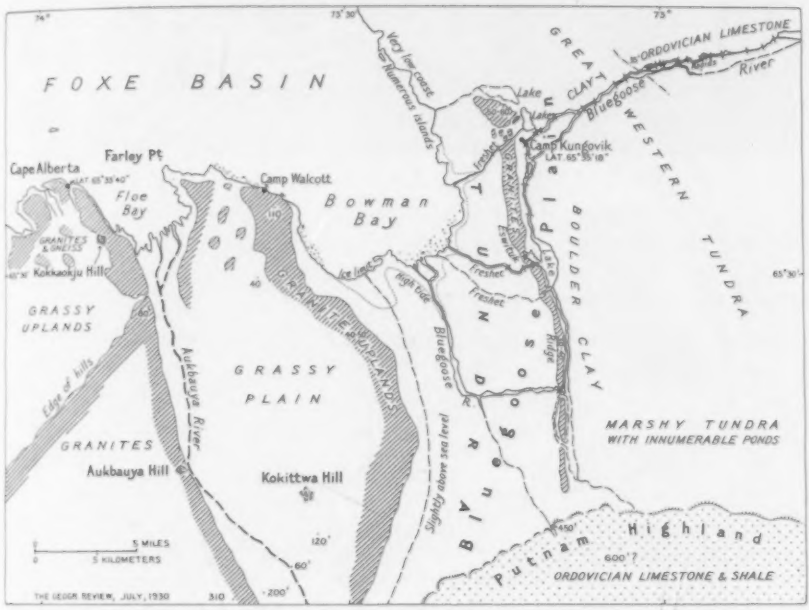

FIG. 15—Map of the vicinity of Bowman Bay. Scale approximately 1:538,000.

The Pre-Cambrian granites and gneisses bordering Chorkbak Inlet develop rugged, though rounded, hills similar in character to those about Andrew Gordon Bay and averaging in height between 250 and 300 feet. In the major western arm, known to the Eskimos as Shukbuk, the hills attain in places elevations of 400 to 450 feet. Glacial erratics, though present, are not as numerous as in the region about and to the north of Andrew Gordon Bay.

Shukbuk Bay is the longest of the arms constituting Chorkbak Inlet and reaches farthest to the north, where it terminates at Kingua in about 64° 57′ 30″ N. The large eastern arm, Shukbaaushik, according to information obtained from the Eskimos of this region, ends several miles short of this latitude. From the head of Shukbuk Bay the terrain rises gradually inland to a local height of land immediately south of Kikkatalik Lake, the latter draining to Foxe Basin about 17 miles distant. The intervening country is of low relief with wide areas of rolling plains crossed at intervals by northwesterly-trending granitic ridges, similar to the glacial plateau to the north and northeast of Tessikjuak Lake.

FIG. 16

FIG. 17

FIG. 18

FIG. 16—Habitat of the blue goose on Bluegoose Plain near Bowman Bay, Foxe Basin, in latitude 65° 29′ N.; blue goose nest in the foreground.

FIG. 17—Eswituk Ridge, looking northwest from Camp Kungovik.

FIG. 18—Limestone banks of the upper Bluegoose River in latitude 65° 38′ 30″ N.

FIG. 19

FIG. 20

FIG. 21

FIG. 19—Landscape at Cape Alberta, south coast of Foxe Basin.
FIG. 20—Camp south of Cape Ketoria, Foxe Basin, latitude 65° 23′ 50″ N.
FIG. 21—Pack ice on the Foxe Basin coast near the mouth of the Kommanik River.

Northeast of Kikkatalik Lake the plateau gradually increases in elevation until it terminates abruptly in a scarp trending northwest-southeast, 14 miles south of Bowman Bay, where it shows a height, by aneroid, of 310 feet above sea level. There is a rapid descent here to a bench at 200 feet, and another to the Aukbauya River at a height of 60 feet. To the northeast is a slightly inclined plain, with a general elevation of 120 feet above sea level, from which rises the prominent hill, Kokittwa. Beyond this there is a gradual descent to the low flat plain between Bowman Bay and Putnam Highland. The western extremity of Putnam Highland, is in 65° 18′ N., from which point it trends southeasterly to terminate on the western shore of Amadjuak Lake in about 64° 40′ N. The southernmost margin of the formation, therefore, lies about 60 miles north of Hudson Strait.

After eight days of hard travel the writer's party reached the proposed site of the summer camp on the bank of a tundra river, near Foxe Basin, in 05° 35′ 18″ N. This was named Camp Kungovik, after the Eskimo name for the blue goose. On May 25 three Eskimos with all the sledges and dogs started on the back trail to Cape Dorset, while two natives, Kavivau and Ashuna, were retained as assistants for the summer.

Camp Kungovik was occupied from May 24 to July 20, during which period the quest for the blue goose came to a successful conclusion.[11] As time permitted, during the summer, a trigonometrical survey was carried out for the major topographical features of the region, including a survey of the Bluegoose River from Bowman Bay for a distance of 34 miles into the interior.

Leaving Camp Kungovik on July 20, the party descended the Bluegoose River by canoe to Bowman Bay and thence followed the south shore of Foxe Basin via Camp Walcott to Cape Alberta (65° 33′ 40″ N.), where a halt was enforced by ice conditions from July 25 to August 6. Advantage was taken of the delay to carry out a local triangulation which was furthermore coördinated with the work done earlier at Camp Kungovik by means of bearings on prominent fixed points on Putnam Highland.

After the long delay at Cape Alberta, a lead in the Foxe Basin pack ice finally developed, which permitted our escape to Cape Ketoria, about 28 miles to the southwest. Beyond this, to the west, ice conditions were as bad as possible. The whole visible basin was densely jammed to the shores with heavy old floes in which not the smallest amount of open water appeared. After working our way between the pack and the coast to the southeast, the mainland was finally reached at the extremity of a short peninsula where a latitude

[11] J. Dewey Soper: Discovery of the Breeding Grounds of the Blue Goose, *Canadian Field-Naturalist*, Vol. 44, 1930, pp. 1–11.

of 65° 24′ was obtained. From here to the mouth of the Kommanik River progress was very slow and laborious.

The only possible way of navigation, as was soon discovered, was to advance slowly on each of the two high tides daily in the narrow water lane that developed between the grounded pack ice and the low shore. In many places, owing to the congestion of massive ice along the coast, portages were necessitated across ice floes and points of land to narrow shore leads beyond. One of the peculiarities of the region is the wide mud flats exposed at low tide, which extend for considerable distances from the coast.

The whole northern coast of Foxe Land between Bowman Bay and the mouth of the Kommanik River is generally low. Grassy plains of considerable extent are characteristic of the entire territory, together with numerous ponds, small lakes, and ridges of Pre-Cambrian crystallines bearing northwest-southeast, the ends of which appear at intervals along the northern coast. On the western shore of Bowman Bay a paralleling ridge of intrusive granites, schists and gneisses rises to heights of 50 to 110 feet. At Cape Alberta the ridges are considerably lower, with interspersed grassy uplands, which rise gradually to the south to meet an intensely glaciated plateau of the old base-complex rocks at an elevation of between 200 and 300 feet above sea level. The whole region has suffered severe glacial denudation, as is exhibited by the polished and striated surface and the flatly convex profile of the great majority of the hills and ridges. Large perched boulders occur here and there on the hilltops, though such erratics are not abundant.

Cape Ketoria is the terminal coastal expression of a range of flattened hills and ridges which trend across country to the north of Chorkbak Inlet and south of Kikkatalik Lake. Somewhat southeast of the cape the hills are prominent with elevations of 50 to 60 feet. The rocks are largely gneisses and schists in which garnets occur in great abundance. They are especially remarkable on the low, polished rocks along the shores of islands and mainland immediately southeast of Cape Ketoria. Gould's mention[12] of garnetiferous gneisses and schists in mid-sections of the north coast of Foxe Land probably has reference to the rocks of this locality.

Hope of reaching Hudson Strait in time to catch the annual ship was several times abandoned, but a stubborn fight was nevertheless maintained over the 70 miles of ice-ridden coast to the mouth of the Kommanik River, which was reached on August 11. The remarkable difference in the ice conditions of Foxe Basin in 1929, as compared with those of 1927 reported upon by Putnam, was a matter of considerable surprise. The Eskimos assert, however, that the open conditions which prevailed in 1927 are rather unusual and that the

[12] Gould, Report on the Physical Geography, p. 32.

ice encountered by the writer's party is more nearly normal. The unique navigation of such a sea as Foxe Basin in a canoe was at first thought to be an act of questionable wisdom; but, as things turned out, it is certain that a canoe offered the only means of escape from the basin in 1929.

The Kommanik River, which has already been described, was ascended with further difficulties and many portages to Ungmaluktuk, Tessikjuak, and the chain of lakes to the south, which provided a continuation of this previously unexplored route from Foxe Basin to Hudson Strait. After a struggle of 28 days, the last ten of which were sustained by enforced hunting owing to exhaustion of supplies, Cape Dorset was finally reached on August 17. Passage home was secured on the Canadian Government steamship *Beothic*, which was successfully intercepted at Lake Harbour, 260 miles east of Cape Dorset, on August 25.

APPENDIX

Notes on Surveys

Coastal surveys were made by means of a large freighter canoe with outboard motor, which admitted of very close adherence to the shore line for detail. Measurements were made with a Negus taffrail log, the clock register of which indicated statute miles and tenths, while the majority of the bearings were secured either with a four-inch prismatic compass or a four-inch surveying compass with Jacob staff. On various capes the transit was employed for important long-range bearings, where frequently observations for latitude and magnetic declination were also obtained. Log values were customarily secured on return trips, which served as a valuable check on the original work, especially where it was possible to traverse the mouths of bays and inlets from point to point.

On winter journeys, measurements of distance were made with a sledge meter, and courses were run with the large open-faced surveying compass. These were checked by latitude observations every noon when conditions were favorable. In January, when the sun was too low for reliable results, latitude was determined by a meridian altitude of Venus, which was very favorably disposed at this time shortly after 3 p. m. A large series was also obtained on Polaris and other stars, as well as on Mars and Jupiter; but later in the year the sun was usually employed, as it was much more convenient on long, hard journeys, with sub-zero temperatures.

Nearly all astronomical observations were made with a D.L.S. five-inch, repeating transit theodolite equipped with a trough compass of great sensitiveness. With this, over 500 observations were obtained for magnetic declination; and, in addition, it was very useful for setting the instrument approximately in position for daylight observations on the polestar. On occasional reconnaissance trips afoot, where weight was a necessary consideration, a box sextant with dark-glass artificial horizon was useful for securing approximate latitudes, as well as for measuring angles.

At various places, such as Dorset, Camp Kungovik, and Cape Alberta, where time permitted, topographical detail was filled in by transit triangulation referred to a reference line in the astronomic meridian. At such points the work is consequently of a more accurate nature, and it was further supported by comparatively precise determinations for latitude derived from the mean of a large number of observations on the sun and the polestar.

TUSAYAN: THE HOPI INDIAN COUNTRY OF ARIZONA

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THE Hopi[1] Indians are a minority group in the great area of Indian country in northeastern Arizona overlapping into three neighboring states and known as "the Navajo country." It includes a block of contiguous Indian reservations of 22,400 square miles, with about 35,000 Indians, of whom the majority are Navajos, and less than 600 whites, who are government employees, traders, or missionaries. The Hopis number only 2800; but, in spite of their small numbers, they perhaps challenge more popular interest than any other Indian group. The interest in the Hopis centers largely about the snake dance, which has attracted more attention than any other Indian dance or ceremonial, and is reinforced by their picturesque pueblo houses perched high on steep-walled mesas rising hundreds of feet above the valley floors and reached only by steep trails or more lately by difficult and precarious roadways.

The Hopi Villages

The Hopi Indian Reservation, as established in 1882, contains 3920 square miles; but even on this, their own reservation, of which they occupy a minor portion, the Hopis are outnumbered by the Navajos. The Hopi villages are situated about 65 miles north of Holbrook and Winslow, the nearest railway stations. If we except the village of Moenkopi in the Tuba Oasis in the Western Navajo Reservation, the greatest air line distance between villages (Walpi and Hotevilla) is only about 18 miles, and nearly all of them can be seen from certain vantage points. The country occupied and utilized by the Hopis was known to the Spaniards as the "Province of Tusayan." Tusayan may be defined as extending east and west across the mesas between the Jadito and Dinnebito Washes, a distance of less than 40 miles with a width hardly half as great—a small area, yet with hardly a rival in the United States as a distinctive geographic unit. The Hopi mesas with their scalloped sinuous contours project "like withered fingers" southward toward the desert from the great Black or Zih-li-jini Mesa, which is centrally located in the Arizona

[1] The name "Moqui," formerly more commonly used, is the name given the Hopis by surrounding Indians, particularly the Navajos. It means "the dead ones" and is resented by the Hopis, whose own name for themselves is "Hopi," meaning "the peaceful people."

part of the Navajo country. The villages are located on the three best-defined projections, called, with reference to their location from the Indian Agency at Keams Canyon, the First, Second, and Third Mesas. On each of the three mesas are situated three villages. The villages, with their population in 1929, are: on the First Mesa, Walpi, 161; Sichomovi, 310; and Tewa, or Hano, 308; on the Second Mesa they are Mishongnovi, 266; Shipaulovi, 116; and Shongopovi, 299; and on the Third they are Oraibi, 422; Hotevilla, 440; and Bacabi, 147.

Surrounding the Hopis on all sides as unwelcome neighbors are the more numerous Navajos, unrelated to them and differing widely from them in customs, traditions, and mode of life.[2] In the past the nomadic, stock-raising Navajos as the stronger tribe have been very troublesome to the Hopis, infringing upon their watering places, monopolizing their pastures, and stealing the products of their fields and their stock.[3] It took the government a long time to secure complete justice between the tribes.

We may suppose, on the support of Hopi traditions, that their early settlements were small or scattered villages located at or near their fields. They seem to have thus pursued their existence quite peacefully, as far as outside interference was concerned, until there came a day when wilder unsettled tribes drifted into the region. The scattered settlements were first assembled into large villages necessitating a smaller part of the male population to remain on guard. Finally they were moved to sites that afforded better facilities for defense but were as near their fields as possible, that is on lower spurs of the mesas or on foothills overlooking little valleys, where nearly all were found upon the arrival of the Spaniards in the sixteenth century.

Seeking protection from Spanish reprisals after their revolt from Spanish rule in 1680,[4] they moved from the foothills or lower terraces up on top of the mesas and built their villages as citadels, risking scarcity of water and depending upon pools in the rocks during sieges. The need for protection has long since passed, but tradition and religious ceremony have become so interwoven with definite locations that the Hopis continue to cling to their barren village sites above the cliffs.

Every modern Hopi village is built on a bare rock surface on the brow of a cliff. The First Mesa is the narrowest, steepest, and most

[2] Cf. H. E. Gregory: The Navajo Country, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 561–577 and 652–672.

[3] Julian Scott: Report on the Moqui Pueblos of Arizona, in Thomas Donaldson: Moqui Pueblo Indians of Arizona and Pueblo Indians of New Mexico, pp. 51–68 (especially pp. 56 and 60), *11th Census Extra Bull.*, Washington, 1893.

Cosmos Mindeleff: Location of Tusayan Clans, *19th Ann. Rept. Bur. of Amer. Ethnology, for 1897–98*, pp. 639–653.

[4] H. H. Bancroft: History of the Pacific States of North America, Vol. 12, Arizona and New Mexico 1530–1888, San Francisco, 1888, p. 349.

sightly. The entire area upon which its three villages rest is not more than ten acres. Immediately back of Tewa, the third village, is a break in the mesa that is difficult to cross. The distance from here to the point of the mesa at Walpi is not more than half a mile, and the mesa is nowhere over 350 feet in width. The entire area is wind-swept, without soil, and completely surrounded by vertical cliffs. At Walpi

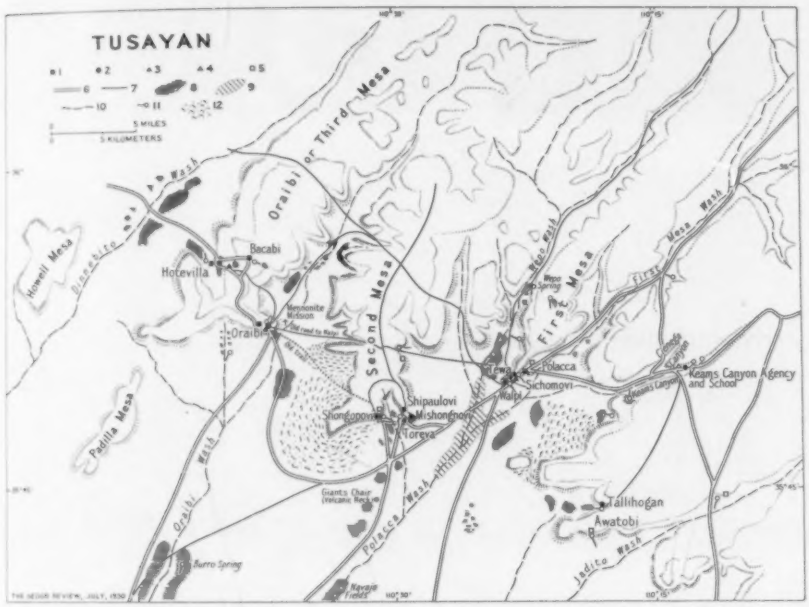


FIG. 1—Sketch map of the Hopi Indian country of Arizona. The numbers have reference: 1, Hopi pueblos; 2, other villages; 3, school and post office; 4, school; 5, pueblo ruins; 6, frequented roads; 7, secondary or abandoned roadways; 8, areas subject to tillage; 9, abandoned fields; 10, most important washes; 11, springs; 12, badlands. Scale 1 : 650,000.

the mesa is hardly 2000 feet wide on top, and toward Sichomovi it narrows to about eight feet. The path between these two villages would be a dizzy one but for the fact that the feet of men and beast have through the centuries worn it into a deep groove. The villages are necessarily close together, and Sichomovi and Tewa have flattened out until they have merged. On the Second Mesa, Mishongnovi and Shipaulovi stand on summits of a narrow secondary projection and, like the villages of the First Mesa, are restricted in area. On the other hand, Shongopovi and the villages of the Third Mesa occupy fairly wide summit areas and are more symmetrical in plan.

To quote Mindeleff: "Pueblo architecture is essentially a product of the plateau country, and its bounds are, in fact, practically coincident with those of that peculiar region popularly known as the mesa country. Peculiar geological conditions have produced a peculiar topography, which in turn has acted on the human inhabitants of the

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Walpi, west side of First Mesa, looking over the Wepo Wash to the Second Mesa in the distance.

FIG. 3—Court at Tewa, First Mesa. Walpi in the distance.

FIG. 4—Shipaulovi, on the Second Mesa. Note the cliff terrace, the sand hills piled against it, and the peach trees growing in the sand.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—Mishongnovi, from terrace below.

FIG. 6—Looking east from Shongopovi. Entrance to kivas in background. Shipaulovi and Mishongnovi on summits in middle distance, and First Mesa projecting in far distance.

FIG. 7—Court in old Oraibi. The snake dance formerly held here went with the Snake Clan to Hotevilla.

country and produced that characteristic and distinctive phase of culture which we call pueblo art."

The Hopi village, designed for security, was built solidly around a court. More houses were added by building on the roofs of the first; and often a third story or even a fourth story was thus added, the upper stories being terraced back from the court. If the village continued to grow, other courts were added or the houses were built in rows parallel to those on the court. Shipaulovi, the smallest village, is built around a single court. The other villages have one main court, in which are held the various dances or ceremonials; and most of them include one or more other courts smaller or only partly enclosed. Owing to lack of space, the court at Walpi is small and opens on one side to the cliff, making it a precarious place for the crowds who come every other year to view the snake dance. Oraibi and Hotevilla are arranged in irregular rows, and their courts are but partly enclosed.[5] Bacabi, the most modern of the villages, built as late as 1908, was laid out by the superintendent of the agency at the request of the Indians. The houses were built separately; but, as the village grows, the spaces between houses are being filled in, and courts are developing as in the other villages.

The Hopi houses are of stone, the one kind of building material plentifully available. As compared with the later prehistoric ruins of the Navajo country, they are poorly laid and dressed. The ceilings are made in the prehistoric fashion, with poles laid over juniper beams and then covered over with brush and clay. The walls are plastered with adobe and whitewashed with kaolin, which is available in the shale of the mesas. In a corner of the room is a fireplace, provided with a hood and served by a chimney whose exit is often marked by a pot whose bottom has been broken out. Formerly there were no doorways into the lowest story. Entrance to the lower rooms was made through a hole in the roof, which was reached by a rude ladder. The women build the houses. Do not pity them for this; for, having built them, they possess them; and, at that, the husband brings in the materials for the building and also the fuel. He tills the fields and claims their products until he brings them home, when the woman takes possession. Should she decide him unworthy, she may put his saddle and blanket with his few other belongings outside, and he has no recourse other than to go back to his own family.

None of the pueblos has any sewage system or regular place of deposit. Refuse is thrown over the cliff, if indeed it gets that far. The journey up the trails is made unpleasant by the sights and odors encountered as the summits are neared. Altitude, pure dry air, bright

[5] For ground plans of the Hopi villages, see Victor Mindeleff: A Study of Pueblo Architecture in Tusayan and Cibola, *8th Ann. Rept. Bur. of Amer. Ethnology, for 1886–87*, pp. 13–228 (plans, pp. 61–79); or Cosmos Mindeleff, *op. cit.*

sunshine, and sweep of wind act as scavengers to protect the villages somewhat from pestilences, which would undoubtedly depopulate them if they were built in the same way at lower altitudes on the plains. The selective factor may also have favored the villages set on the heights and may have been partly responsible for the tenacity with which the Hopis have clung to them after all apparent advantages have passed. The compactness of the villages with their filth has greatly increased the hazards of disease and rendered it difficult to control. Tuberculosis and trachoma are common, and epidemics of smallpox and measles have sometimes swept through the towns. The worst occurred in 1853–1854;[6] the last serious epidemic of smallpox broke out in the winter of 1898–1899 when many died. An outbreak in the winter of 1917 was effectively checked by virtue of rigid quarantine and wholesale vaccination (800 in one day).

The Mesas

After coming over the highly colorful areas that surround the Black Mesa, the visitor is likely to be disappointed to find that the pueblos are colorless, drab, and gray, subdued as are the rocks of the mesas from whose stones they are built, and blending with the desolate-appearing landscape. The mesas are made of alternate layers of shale and coarse-grained sandstone of the Mesa Verde formation and rest on the argillaceous and arenaceous Mancos shales.[7] These shales, dissected more readily by erosion, form a hilly zone bordering all the mesas. On the leeward, northeast sides of the mesas, sands blown over the summits find lodging and are piled against the mesa walls, reducing the difficulties of the trails; while on the southwest sides only rocky talus is found.

The sandstone layers in the mesas are the cliff formers. Two layers of thicker sandstone are noticeable, especially in the First and Second Mesas. The one layer caps the mesas and forms the flat rock surfaces upon which the villages are built and is about 50 feet in thickness. The second is about 100 feet lower and about 80 feet in thickness. This lower layer forms a pronounced terrace, on the edge of which are the corrals for the animals, especially the sheep. This terrace is widest at Mishongnovi and Shipaulovi, and these villages are situated on separate summits that rise like terraced islands from the main terrace or platform. Between these two thick sandstone layers are thinner layers of sandstone which form ledges, especially at the First Mesa, on which pigsties and corrals for the burros are

[6] Lieutenant Whipple's Pacific Railroad Survey Report is quoted by Thomas Donaldson, *op. cit.*, p. 28.

[7] For detailed description of the Mesa Verde and Mancos formations as found in this area, see H. E. Gregory: Geology of the Navajo Country, *U. S. Geol. Survey Professional Paper 93*, 1917, pp. 73–76.

arranged.[8] The corrals or sties abut against the cliff on one side, and the other side may be left open to the precipice, making a minimum of stone-wall construction necessary. Much of the refuse thrown from above falls into the pigpens. At Hotevilla alcoves of the mesa benches are fenced with boughs, which serve as hanging balconies

FIG. 8—Animals watering at the spring at Hotevilla. The surplus water goes down to water the terraced gardens below. See Figure 9.

for the burros; and pigs are confined where blocks of sandstone have been split out from the edge of the mesa.

On the First and Second Mesas the trails follow breaks made by joints where stairways have been cut into the rock. The trails are more gradual at Hotevilla and Bacabi; and at Oraibi the sand piled on the leeward, northeast side of the mesa almost to its top has made possible a roadway approach that is easier than to any other village, except as Hotevilla and Bacabi are reached by the continuation of the same road over the top of the mesa or are approached from the west. Even here until recently the roadway up over the cliffs near the summit was perilous. It is possible to ascend to Tewa and Shongopovi by wagon and even automobile; and at Mishongnovi and Shipaulovi a rough roadway extends to the sandstone terrace below the villages.

WATER AND FUEL SUPPLIES

The Hopis obtain their water supply from springs whose source is the contact between the Mancos shale and the sandstones of the

[8] For a splendid photograph of Walpi showing these pigsties and corrals, erroneously referred to as "garden patches," see *Geogr. Rev.*, Vol. 14, 1924, p. 14.

wider-spread Mesa Verde formation. "Water of good quality issues from this horizon at 30 to 40 springs about the edge of the Black Mesa and at other localities where Cretaceous strata are represented."[9] The surfaces of the mesas are the catchment basins for the rain water which does not run off; the coarse porous sandstones are the reservoirs;

FIG. 9—Terraced gardens below the spring at Hotevilla in June, 1928.

and the relatively impervious shales conduct the water to the surface around the bases of the mesas. However, barring improvements by the Indian service, the water supply has been poor indeed.

At the First Mesa the water is obtained from two springs, the most used of which is the "Coyote Spring" at the foot of the Tewa trail. The other is on the opposite side of the mesa. The strongest of all, the Wepo Spring, is four miles to the north but is used only for watering stock or in emergency. Along the road east of the mesa a stagnant pool in the sand, covered with green scum, is now used only for ceremonial purposes. Polacca, the settlement of more progressive Hopis who have left the Mesa, obtains its water from a deep artesian well or from the Coyote Spring. Mishongnovi and Shipaulovi, on the Second Mesa, depend mostly on a spring at the foot of the mesa whose flow has been considerably improved in late years and which has been walled in. The school and post office are located near by, and the place is called Toreva, "crooked," the tradition being that the water comes from a snake which had a hard time getting through the sandstone and made a crooked course in it. On the other side of the villages is a less-used and poorer spring. Shongopovi has two springs:

[9] H. E. Gregory: The Navajo Country, *U. S. Geol. Survey Water-Supply Paper 380*, 1916, p. 138.

one on the southwest side, which is the chief supply for the village; and the other on the east side at the base of the cliffs, where the school is located. The Indians call this place Masepa. At Oraibi on the Third Mesa there is a good well on the east side at the foot of the mesa, where a secondary village has grown up similar to Polacca at the First Mesa. The spring upon which the pueblo formerly depended is on the other side. Hotevilla and Bacabi have the most convenient springs, located just under the capping layer of sandstone, and the villages were located with reference to them. Their flow is slow but sufficient for all domestic needs and for the animals; and in addition there is sufficient overflow to irrigate beautifully terraced gardens, constructed with great labor below the springs.

The landscapes about the Hopi mesas are comparatively desolate, in large measure because of the concentration of population within an area of meager resources easily stripped. The valleys were grazed out long ago by flocks that were held too close to the pueblos; and, as the land became barren, the sands were stirred and drifted with the wind. No wood is now available within miles of any of the villages except the two recently built ones, Hotevilla and Bacabi, though all the mesas were formerly at least sparsely timbered. The Awatobi Mesa, similar in elevation and structure to the others but long unoccupied, has a profuse cover of sage, grass, and scattered juniper. Now fuel must be carefully conserved. Fortunately coal is available; the Indians of the First and Second Mesas have their own mines, and a government mine at Keams Canyon supplies the agency and Indian school located there.[10] At the First Mesa especially, dried sheep manure is systematically piled along the edge of the mesa for the purpose of firing pottery, as it retains the heat much better than wood or coal.

Fields and Crops

The fields of the Hopis are located on the drifting sands in the valley bottoms near the washes, or wherever there is sufficient moisture from some gulch or spring, and are at considerable distances from the pueblos. Before the government came in, it is said that some of the Indians used to go as far as 45 miles to the fields every day. No wonder they are notable runners. Latterly the most distant fields are not more than 15 miles from the villages. Some one goes out to the fields every day, or some go and stay for a number of weeks but return to the villages for dances and for the winter. Temporary shelters are built for those who tend the crop. Sheep herders also go out with their flocks, remaining for some time in one locality and returning each night to a corral and hogan.

[10] For description of coal in the formations of the Black Mesa, see Gregory, Geology of the Navajo Country, pp. 142–144.

The amount of land farmed by a Hopi family varies from two to ten acres and may be scattered in small patches. But a Hopi farm is not a fixed quantity, as cultivation follows the sand drift where the moisture is conserved and the wind helps to keep a surface mulch. But the sand is likely to be blown out of the bare fields into adjacent areas, and so the fields move. Attempts to assign allotments of land to the Hopis have failed dismally owing to the shifting moisture conditions. Land division among the Hopis goes by clans. Cases of land trouble are settled by clan markings.

The principal field crops with both Hopis and Navajos, as with other Indians of the Southwest, are corn, beans, melons, squash, pumpkins, and wheat. With the exception of wheat, these products have been grown by them from prehistoric time. But, while among the Indians of southern Arizona wheat has supplanted corn as the leading cereal, in the north corn remains the dominant crop and staple of diet. The Hopi Indian Agency gives 750,000 bushels as an average crop. Through many centuries of effort the Hopis have developed a drought-resisting variety

FIG. 10

FIG. 11

FIG. 12

FIG. 10—Chief of the Walpi Snake Clan planting corn with planting stick. (Photograph by Emory Kopta.)

FIG. 11—Reed windbreaks protect the corn from wind and sand in its first stages. (Photograph by Emory Kopta).

FIG. 12—Corn stored in Hopi home. (Photograph by Emory Kopta.)

of corn only a few feet high. As compared with an eastern cornfield, the Hopi field at its best is an unpromising sight but usually yields fairly well. The Hopi woman is reputed to know at least twenty ways of preparing corn. Most of it is plucked when still young and cooked in the shucks and allowed to dry. When ready to be used it is heated over, and, although darker in color, in appearance and taste it has lost little. Much of the corn is also allowed to harden on the stalks and is ground into meal.

At one time wild cotton was of considerable importance and was also cultivated. Before the coming of the Spaniards the Hopis wore cotton garments made from cotton they themselves gathered and dyed with unfading mineral and vegetable dyes. The Hopi cotton is a very distinctive species, remarkable for its rapidity of growth and early maturing. In experiments of the United States Department of Agriculture, bolls have been ripened in 84 days from the sowing of the seed.[11]

Only within the last several years have potatoes been grown to any extent, though the soil is suitable, and wild tubers grow in some of the hollows. The gray speckled pinto is the bean most grown. Pinto beans are eaten green until it is time to pull the stalks, when all beans left on them are shelled: none are wasted. With the coming of frost all the green melons are also gathered and kept till as late as January or February.

The Hopi and Navajo get their crops in the face of odds with which the white man would not try to contend. The first attempts of the United States government in farming in Tusayan were complete failures and were laughed at by the Indians. The Hopi farmer has to contend not only with drought but with wind, floods, and the inroads of worms, birds, and mice. The total annual rainfall averages but little over ten inches and is not ideally distributed. The spring months have least rainfall; and May and June, the months when most crops should get their early growth, receive hardly more than one-twentieth of that for the year. Nearly one-third of the rainfall comes in July and August. Most of that is due to thundershowers, which are often so violent that they may well be called cloud-bursts, and much of the water runs off quickly. The dry spring months are also the windy months, but the winds cease with the coming of the summer rains. At this altitude of over a mile the spring months are still cool or cold, and nothing sprouts until early in May. At Keams Canyon the average date of the last killing frost in spring is May 18, and frosts have been recorded as late as June 3 and 4; but the short summers are quite warm or hot. Struggling against such odds through long periods of time, the Hopis have ingeniously adjusted

[11] Frederick L. Lewton: The Cotton of the Hopi Indians: A New Species of Gossypium, *Smithsonian Misc. Colls.*, Vol. 60, No. 6, Washington, 1912.

their agricultural practice to the point where fair crops may be expected.

To conserve moisture, the hills of corn are set about six feet apart. A piece of iron pipe is used to jab a hole about a foot deep, the object being to loosen the hard layer below the surface. Before iron pipes were available the Indians used a corn planting stick about two-and-a-half feet long and an inch in diameter with a broad wedgelike edge. The holes are filled with loose soil to about five inches from the top at which depth the corn is planted in order to protect the young shoots from the wind and make more moisture available. Much seed is used to allow for losses caused by cutworms, birds, field mice, and wind-driven sand; and replanting continues to July. The thickly set plants which survive afford each other protection and support. Rows of reeds are often set as windbreaks to ward off the drifting sands (Fig. 11), and single stones may be used to protect the melon or bean hills.

Some early sweet corn is planted in April or May in very sheltered sunny slopes where moisture is retained in the sand from late winter or early spring rains. This corn comes to maturity in time for the big ceremonial Kachina Dance about July 25. The later corn, called "pig corn," furnishes the main supply. It is planted in June but does not start growing before the first rains, about the first of July.

All fields, before they are planted, are tested for moisture. The Indians are skilled in the selection of patches benefited by underground drainage, and surface drainage is also taken into account. Fields are selected for cultivation which are liable to be inundated during the rains of July and August. Parts of the fields are stripped by the flood waters, and others are buried in silt; but what remains constitutes the irrigated fields from which a crop is harvested. In some instances earthen dams are constructed to direct the floods and prevent excessive erosion.

In late years the cutting of deep arroyos into the older alluvial fill of the valleys has aggravated the Hopi farm problem. The greatest trenching has taken place within the last 10 or 15 years. Before 1880 there was no serious arroyo wash in Keams Canyon, but later the government experimental farm there was largely washed away and had to be abandoned. The school was moved two miles down the canyon to its present site. The wash is now about 25 feet deep and goes through the middle of the old fields and cemetery. The old Oraibi Wash of 30 years ago was no more than five or six feet deep and can still be traced where it was abandoned for the great gash about 35 feet deep and several hundred feet across. Locally it has cut to bed rock, and here there is a constant flow of surface water. It is representative of what has taken place in all the valleys. The accelerated erosion may be due in part at least to overgrazing, as

the country has been overstocked in the last 20 years, but increased erosion has been quite general in Arizona and the Southwest during the same period.[12] With the deepening of the trenches the underground water is drained off or lowered. Where the flood waters formerly spread out over a width of a mile or more, the arroyo may

FIG. 13—Approach to Second Mesa. Shipaulovi on summit near center; Mishongnovi to the right.

now carry nearly all the water. The areas with sufficient moisture available for cultivation have therefore shrunk considerably, and their further shrinkage remains a serious problem.

According to data supplied by the superintendent of the Hopi Indian Reservation, about 600 acres of land are now irrigated by wells of which there are now from three to six in each wash. About 100,000 acres are estimated to be tillable on the reservation. Irrigation by well water may perhaps make up for the water losses due to channel trenching.

Groups of fruit trees, mostly peaches, are scattered about in the belts of sandy hills which border the mesas. The total area in fruit trees amounts to about 500 acres. Melon and bean patches are also scattered here and there in favorable situations. Experience has evidently taught the Hopis that on the slopes of the foothills the peach crop may be more surely depended upon. The temperatures have been responsible for the foothill locations, but the moisture or lesser evaporation is responsible for the location of the orchards on the northeastern slopes, the prevailing wind direction being southwest. For the same reason the east sides of the mesas with more sand have most of the fruit trees.

The Hopis have learned through hard experience that, in spite of all precautions against the vicissitudes of the elements, the season's

[12] See J. W. Hoover: The Indian Country of Southern Arizona, *Geogr. Rev.*, Vol. 19, 1929, pp. 38–60, especially pp. 41–45; and Kirk Bryan: Historic Evidence on Changes in the Channel of Rio Puerco, a Tributary of the Rio Grande in New Mexico, *Journ. of Geol.*, Vol. 36, 1928, pp. 265–282; *idem*: Flood-Water Farming, *Geogr. Rev.*, Vol. 19, 1929, pp. 444–456.

crop may not be absolutely depended upon, and they always keep enough corn in storage to tide over from one to two years of complete crop failure. Formerly they would on occasion trade children to Mexico for corn to tide off starvation. In 1780 the Spanish governor reported that as the result of a three-years' drought there were 6696

FIG. 14—Dinnebito Wash, the western boundary of Tusayan.

deaths and that the Hopi population was reduced to less than a thousand.[13] However, it is a question whether there was so large a population at this time.

Among the Hopis, as contrasted with the Navajos, pastoral pursuits are secondary to agriculture; but the Hopis have increased their herds considerably in the last 30 years. Improved Hereford stock has been introduced by the government, and the Hopis have made more progress with cattle than have the Navajos. The government has also introduced some fine stallions and is trying to get rid of the burros. The Hopis are now estimated to own about 4500 cattle, 14,200 sheep, 7500 goats, and 3600 horses, burros, and mules. These supply them with meat, wool, skins, and transportation. Hogs, chickens, and slinking dogs are their other domestic animals. Small desert animals, such as rabbits and prairie dogs, are also eaten; and formerly antelope, elk, and deer were captured by being driven into pitfalls or corrals.[14]

As with other Indians of the Southwest, conservation of water is the chief motivation of the religious beliefs and practices of the Hopis and is also the basis for the organization of clans and ceremonials designed to secure the aid of the unseen powers believed to control rainfall. The most notable of these ceremonials is the snake dance held in August, on odd years at Walpi and Mishongnovi, and on even years at Hotevilla, Shongopovi, and Shipaulovi. The ceremonials

[13] Donaldson, *op. cit.*, p. 15.

[14] Handbook of American Indians, *Bur. of Amer. Ethnology Bull. 30*, Vol. 1, p. 566.

held at Hotevilla and Walpi are best known and most visited.[15] The clans with their ceremonials are responsible for isolation and inbreeding and for much of the tenacity with which the Hopis cling to their sightly but unsanitary and inconvenient pueblos.

Hopi Arts

Among the Hopis the art of weaving, so important among the Navajos, is secondary to basketry and pottery. The Hopis were weavers long before the Navajos; but, as the Navajos acquired flocks and learned the arts of spinning and weaving from the Pueblo Indians, the Pueblos, including the Hopis, turned their attention more to pottery and basketry as they came to depend chiefly upon tilling the soil as a means of subsistence. But some of the best weaves are still done by the Hopi and are superior in texture to any of the Navajo work.[16] Among the Navajos the weaving is done by the women, but among the Hopis it is done chiefly by the men.

The Second and Third Mesas specialize in basketry, and each has its own type of weave and decoration. The First Mesa is favored by a convenient supply of fine clay and has accordingly specialized in pottery. The best clays are found in the shale beds that underlie the capping sandstone layer about 60 feet below the top of the mesa. Most of the clay is dug out along the roadway leading to the top of the mesa at Tewa or in the gap in the mesa north of the village. The deposits are here from 12 to 15 inches thick, while thinner beds occur in the shales farther down. The same clays are found around the Coyote Spring at the foot of the Tewa trail where they have slid from the cliffs above. The Tewa women thus have an advantage in the convenience of the best clays and have become the most skillful potters.

Both yellow and gray clay are used; but, as the gray has greater consistency, about 80 per cent of it is mixed with 20 per cent of the yellow. The yellow clay is also used in decorating the pots. Though yellow when applied, it becomes a rich red when fired. A little of the yellow clay burned on the gray surface gives it a buff finish—an attractive feature of the Hopi pottery.[17] The best of the modern pottery is inferior to that taken from the older pueblo ruins, as at Awatobi and the still older ruin of Sikyatki[18] near Polacca, as they have not yet learned to give it the durability which has preserved the older pottery and its coloring through the exposure of many

[15] For description of the snake dance see J. W. Fewkes: Notes on Tusayan, Snake, and Flute Ceremonies, *19th Ann. Rept. of Bur. of Amer. Ethnology, for 1897–98*, pp. 963–1011.

[16] U. S. Hollister: The Navajo and His Blanket, Denver, 1903, p. 87.

[17] Emory Kopta, Phoenix artist, who has lived among the Hopis many months at different times, has kindly offered information and has assisted in checking the manuscript. Mr. Kopta has the confidence of the Hopis as perhaps no other has.

[18] See Victor Mindeleff, *op. cit.*, p. 24.

centuries. Representatives of the Smithsonian Institution found pottery making among the Hopis well-nigh a lost art, their only wares being of the cruder types. Samples of the older pottery were taken from the ruins, the designs were copied, and a Tewa woman, Nampeo, was taught to draw and apply them.[19] She became noted as the most skilled of the Indian pottery makers, and her work is still in great demand. She is now quite old, but her art has been passed on to other women, some of whose work rivals her own.

Navajos and Hopis both have their silversmiths who hammer out beautiful designs in jewelry, especially bracelets and rings, from silver pesos obtained from Mexico. The Hopi silversmiths are fewer, and their workmanship is cruder than that of the Navajos who help to supply the Hopis with these articles.

Movements of the Population, Past and Present

Under the influence of a higher and stronger civilization, bringing with it security, the process of concentration in the pueblos is now being reversed. Lately the villages have begun to flatten or actually to disintegrate in favor of smaller groupings or of scattered homes below the mesas.

By virtue of its location, the agency at Keams Canyon has exerted most influence upon the First Mesa, and on the whole the people of the First Mesa have been most progressive. Hotevilla, the village farthest from the agency, is today the most conservative. Until 1906 Oraibi was the only village on the Third Mesa and was the largest of all. In the census of 1890 Oraibi was reported to have a population of 830, or nearly half the total Hopi population at that time. Today a large proportion of the Oraibi people live outside their pueblo, and it is rapidly becoming another ruin. For a long time Oraibi was also the stronghold of conservatism; but the spirit of progress was stirring, and a crisis was brought about by a series of lean years. From 1880 to 1904 there was a period of great drought ended by heavy rains which swept away farms and cut the Oraibi Wash, lowering the water table.[20] It became urgent for some of the inhabitants to seek their fortunes elsewhere. Dissatisfaction developed dissension and final cleavage. In 1906 the progressive element, who wished to coöperate with the United States government particularly with reference to the education of their children, drove out the conservatives with their chief, Youkeoma (died March, 1929). The evicted element found a new site and built the pueblo of Hotevilla. Several years

[19] See A. V. Kidder's introduction to "Pueblo Pottery Making," by Carl E. Guthe, New Haven, 1925.

[20] Noted by Dr. A. E. Douglass in his account of the latest discoveries in the tree ring studies of the Southwest ("The Secret of the Southwest Solved by Talkative Tree Rings," *Natl. Geogr. Mag.*, Vol. 56, 1929, pp. 737–770). Valuable records have been obtained from pine logs in the Hopi villages (compare *idem*: Climatic Cycles and Tree-Growth, *Carnegie Instn. Publ. No. 289*, 1928, Vol. 2).

later another schism at Hotevilla resulted in driving off a less conservative group, who were also rejected by the Oraibians and were in distress until assisted by the Indian service in locating a new village at the present site of Bacabi. The sites of these new villages are less picturesque; but, as has been described, they are favored by supplies of water and fuel in the immediate neighborhood. However, they are much bothered with drifting sands. In the dry windy season of spring and early summer of 1928 a number of houses at Hotevilla were buried or filled with sand and had to be abandoned.

By 1890 one Indian, Tom Polacca, had shown courage enough to come down from First Mesa and live at its foot. In 1891 the government began the building and equipment of houses for the Indians, 100 houses being at their disposal by 1900; but ten years later not more than half of them were used even temporarily. Doors, windows, and floors were removed and carried up to the mesa. The houses that now remain are rented to tourists at a handsome profit to the Indians. Such was the beginning of the group of scattered houses on the east side of the First Mesa which goes by the name of Polacca. At present about seven per cent of the Indians live off the mesa. Others have built houses or occupied government-built houses on their farm lands.

Oraibi is also largely parent to a third village, Moenkopi, located about forty miles west in the Tuba Oasis. Under the shadow of the Indian agency at Tuba, the Hopi population of the oasis has increased from a single family in 1880 to 365 persons in 1928. Most of these came originally from Oraibi, at first living at Moenkopi only during the growing season and returning to Oraibi for the winter months. Many who farm on the Tuba Oasis still return to Oraibi during the winter.

The Tuba Oasis is the most favored spot in the Navajo country judged from the standpoint of fertility and water supply, although it lies on the margin of the most desert area. Moenkopi itself shares with the other Hopi villages its location on a bare rock surface on top of a rocky bluff. It is situated where the Reservoir Canyon from the north joins the Moenkopi Wash, draining westward and bounded by picturesquely carved cliffs of bright red sandstone and shale. The flow from the Moenkopi, combined with that from Reservoir Canyon and the springs in the canyon wall, is capable of irrigating about 1000 acres on the floor of the Moenkopi Wash,[21] about 600 of which are actually under cultivation.

Tuba, the seat of the Western Navajo Reservation agency, is located about two miles from Moenkopi, farther up on the mesa, where there are three springs with an average flow of nearly 80 gallons

[21] H. E. Gregory: The Oasis of Tuba, Arizona, *Annals Assn. of Amer. Geogrs.*, Vol. 5, 1915, pp. 107–119.

a minute. Tuba and the Tuba Oasis were purchased by the government in 1903 from Mormon pioneers who had settled there in 1876.

Other movements or changes have taken place locally with the Hopi population within historic time as recorded by the accounts of the Indians and by abandoned pueblo ruins. A map by John Sextes of the Royal Society of London, published in 1710, shows ten Hopi

FIG. 15—The beautiful little oasis of Tallihogan, south of Keams Canyon.

villages, only two of which, Oraibi (Orawi) and Walpi (Gualpi) are inhabited today. Oraibi is the most ancient-looking of the pueblos and is probably the only one occupying the same site as when first visited by white men in 1540. Walpi, Mishongnovi, and Shongopovi were first situated on the foothills or on the lower terraces. Prehistoric Walpi was situated down in the foothills to the northwest of the present town; but, according to Indian accounts, it was moved onto the lower ledge of the mesa on the east side to secure more sun and warmth. Here the Spaniards found the village; but after the revolt of 1680, fearing reprisal, the Indians moved on top of the mesa, taking the timbers from the Spanish church with them. The walls of old Mishongnovi are barely traceable on the terrace below the present pueblo. An especially large ruin, estimated to have accommodated 2000 people, is located below Shongopovi near the spring on the east side. According to the Indian story, all but seven families were killed by the Spaniards in revenge for the killing of their missionary. Those who escaped went up on top of the mesa and started the present village.

Shipaulovi, on the Second Mesa, was founded after the Spanish invasion; and Tewa, the third village of the First Mesa, was founded

about 1700 as a home for some hired fighting men. Harassed by Navajos, Utes, and Apaches, they sought aid of the Tewa Pueblo Indians on the Rio Grande, who took possession of the new village and gave it the name of Tewa.[22] The village was provided as an inducement, and they were also granted the valley west of the mesa. Although in close contact with the Hopis for over 200 years, they have not been absorbed and have retained their Tewa dialect. Formerly the warriors, they are now the policemen for the Hopi country and as such are the most dependable and courageous.[23]

The pueblo first approached by the Spaniards was Awatobi, on the extremity of the mesa south of Keams Canyon. According to Hopi accounts the town was destroyed by the people of Mishongnovi and Walpi. They explain this attack by saying that "the town was full of 'singing men' whom the Moquis did not like," probably Spanish missionaries chanting the offices of the Catholic Church.[24] Other larger and older ruins are located on the southeastern side of the same mesa at the Jadito Spring and overlooking the Jadito Wash. The size of the ruins indicates that they must have accommodated upwards of 1500 people. In all there are seven or eight ruins on the larger East Mesa located wherever there is a seep or spring.

The springs at Awatobi and Jadito, like those at Hotevilla and Jacobi, were just below the villages, emerging from underneath the capping layer of sandstone. Though at present hardly more than seeps, they were once perhaps strong-flowing springs. The Hopis say that all these springs were stopped up by them. A short distance north of the Awatobi ruin in a wide canyon under the capping layer of sandstone is the "House-rock" Spring, very good today in flow and quality of water.

In late years a few more progressive Hopis and Navajos have challenged the taboos that have developed about the East Mesa and its springs and have built homes below the House-rock Spring and turned its waters into their fields and orchards, establishing a small but beautiful oasis which they call Tallihogan. With some improvement of the spring the water supply here would be better than that of the other mesas. Add to this the convenience of the water supply, the plentiful fuel on top of the mesa, the abundant fertile soil immediately below, and the cliff with bare rock surface (required by all conservative Hopis) immediately above the spring, and the situation at Tallihogan is certainly ideal for a large Hopi settlement. Taboos as yet are strong; but, as time goes on, economic well-being will gradually obtain the mastery over tradition in guiding the destinies of the Hopi.

[22] Scott, *loc. cit.*, p. 62.

[23] Leo Crane: Indians of the Enchanted Desert, Boston, 1925, p. 137.

[24] J. G. Bourke: The Snake-Dance of the Moquis of Arizona, New York, 1884, p. 90. Compare Walter Hough: The Hopi Indians, Cedar Rapids, Iowa, 1915, pp. 209–210.

NOTES ON THE CLIMATE AND PHYSIOGRAPHY OF SOUTHWESTERN ECUADOR

George Sheppard

THE coastal region of southwestern Ecuador has attracted considerable attention through the investigations for petroleum lately carried on there under the stimulus of the rapidly increasing development of the rich Peruvian fields of the Paita-Tumbes coastal region immediately to the south.[1] Apart from commercial possibilities the region might well claim the interest of geographers on account of the peculiar features of its surface configuration. In recent geological times an immense amount of erosion has taken place, resulting in a remarkable sculpture; and the processes can be seen in operation at the present day. The region, however, is one of scant rainfall. Dr. R. C. Murphy has called attention to the existence of a meteorological frontier running across it from north to south to eastward of which rain falls annually, while to the westward truly appreciable quantities fall only at intervals of years (compare Figs. 6 and 7).[2] In the Santa Elena Peninsula in an average year rain falls only in the months of January–April, this season being the hottest part of the year, and the amount is negligible, rarely exceeding much more than three inches.

It is impossible to explain the existence of such enormous tracts of denuded land surface by assuming only the erosion of a succession of normal rainy seasons. The normal régime, however, is interrupted by the periodic occurrence of exceptionally wet seasons. The extraordinary rains and floods of 1925 and 1926 that swept the arid west coast from Ecuador to Chile are fresh in the memory (Fig. 2). The events of 1925 have been vividly described by Dr. Murphy.[3] Though such rainy years are of irregular periodicity, they have none the less left evidence of their existence in the devastating results of superficial denudation. There is little doubt that most of post-Quaternary earth sculpture, such, for example, as erosion remnants, *tablazo* fringes, inland lagoon areas, "badland" features, and certain steep V-shaped

[1] George Sheppard: Observations on the Geology of the Santa Elena Peninsula, Ecuador, South America, *Journ. Instn. of Petroleum Technologists*, Vol. 13, 1927, pp. 424–461.

[2] See Frank Chapman: The Distribution of Bird-Life in Ecuador: A Contribution to a Study of the Origin of Andean Bird-Life, *Bull. Amer. Museum of Nat. Hist.*, Vol. 55, 1926, p. 27. This climatic line is also a faunal boundary.

[3] R. C. Murphy: Oceanic and Climatic Phenomena along the West Coast of South America during 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54. See also the account of the 1926 season in northwestern Peru by E. Willard Berry: Meteorological Observations at Negritos, Peru, December, 1924, to May, 1925, *Monthly Weather Rev.*, Vol. 55, 1927, pp. 75–76.

valleys, have been caused by the cumulative influence of successive wet seasons.

In addition to the climatic factor consideration must be given to the lithological nature and the geological structure of the regional formation and the tectonic uplift of the coastal belt in progress since the beginning of the Quaternary.

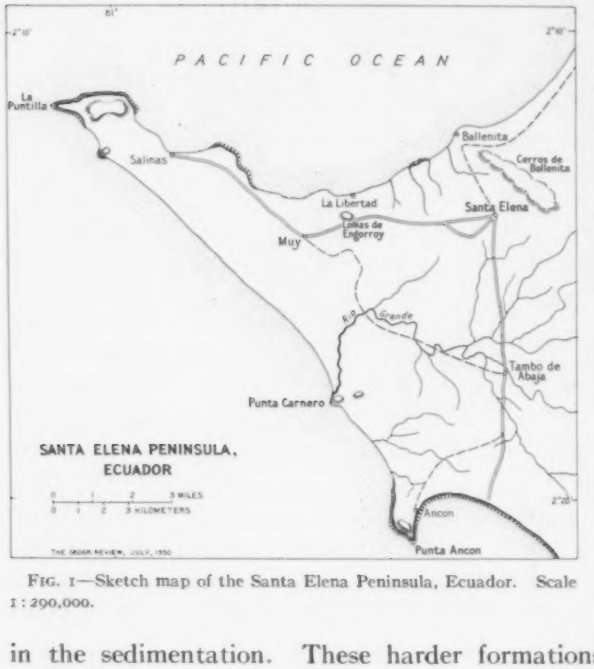


FIG. 1—Sketch map of the Santa Elena Peninsula, Ecuador. Scale 1 : 290,000.

The denuded land surface of southwestern Ecuador, with which we are here concerned, presents a general pampa-like aspect relieved at intervals by numerous conspicuous elevations which form true erosion remnants, these having been preserved purely by reason of the resistant nature of certain lithological phases which occur in the sedimentation. These harder formations include chert, indurated shales, compacted sandstones or conglomerates, and igneous dikes.

THE SANTA ELENA PENINSULA

For purposes of illustration, the Santa Elena Peninsula itself can be described as a type (Fig. 1). Most of the geological formations in the area are Tertiary, frequently overlain unconformably by Quaternary deposits, *tablazos*, upraised sea floors and beaches.[4] From La Puntilla, the most westerly extension of continental Ecuador, eastward to the Cerros de Ballenita and southward to Punta Ancon, a geographical unit of considerable area is found, the general low-lying nature of the topography being relieved by La Puntilla, Punta Carnero, the Lomas de Engorroy, and other small eminences. These latter remnants, which consist of chert rock, are invariably capped by *tablazo* deposits, a succession of terraces being occasionally observed on certain outcrops (Fig. 3).

[4] George Sheppard: Geology of Southwest Ecuador, *Bull. Amer. Assn. of Petroleum Geologists*, Vol. 14, 1930, pp. 263–309; and compare T. O. Bosworth's description of the similar region of the north Peruvian coast, in his "Geology of the Tertiary and Quaternary Periods in the North-West Part of Peru," London, 1922.

The Cerros de Ballenita, forming a flat-topped ridge with a northwesterly trend, do not express the structural geology of the underlying formations. They represent, on the contrary, an erosional outlier which has been left after the area outlined above had been denuded. Although many factors must be considered in order to account for the contour of these hills at the present time, it is to be noted that the main range lies at right angles to the prevailing southwesterly winds, a fact which may partly explain the origin of these natural elevations. Farther to the north, also, a similar escarpment occurs, extending from Punta Centinella southeasterly towards the village of San Vicente. The prominent features in the topography described above, therefore, must have been determined primarily by the continued action of intense phases of subaerial erosion which no doubt were effected during the seasons of abnormal rainfall.

Although the latter seasons occur but once in every ten years or so, it is reasonable to assume that during the intervening years the disintegration of the surface rocks has been gradually proceeding under the combined influences of sun, wind, and mist. The sudden advent of a rainy season, with its consequent rejuvenation of the surface drainage, will effect at once an intense erosion.

The prevailing winds from the ocean are from the west or southwest during the greater part of the year. As they pass over the cool Humboldt Current, they form an important factor in the causation of the subtropical climate of the region; they are also responsible for the heavy mists, *garuas*, which are so common during June, July, and August. The effect of these mists, assisted by the winds from a constant direction, causes a sculpture of the land surface into topographical ridges trending north-

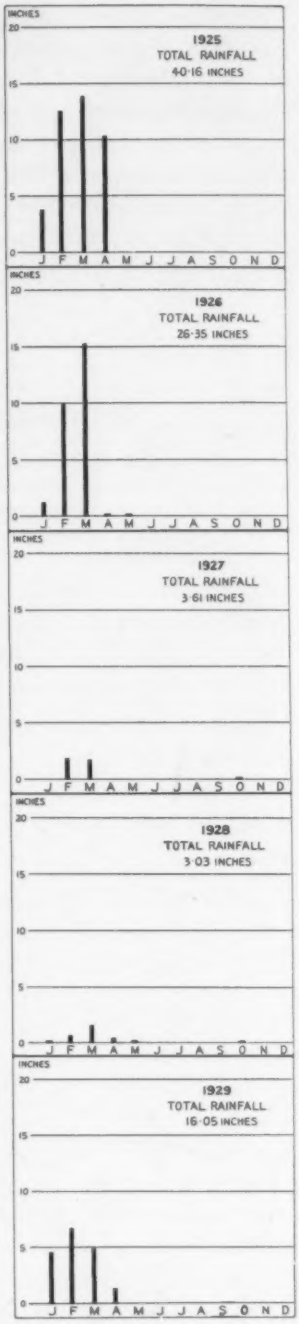


FIG. 2—Rainfall at Ancon, southwestern Ecuador, 1925–1929, illustrating the abnormal seasons of 1925 and 1926.

west to southeast, that is at right angles to the principal wind direction. Furthermore, the southwesterly flanks of these units become etched or corroded by steep stream courses, quebradas, in a more detailed manner than along the corresponding northeasterly slopes.

At present the sparsely distributed vegetation which grows in this region appears to favor the southwesterly flanks of the major ridges, a fact which also indicates the general direction of the moisture-laden winds. A physiographical study of the habit of the larger river

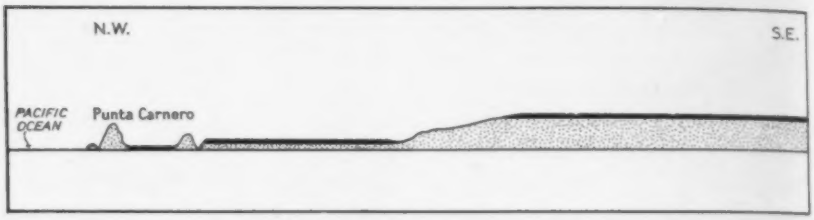


FIG. 3—Diagrammatic cross section illustrating *tablazo* levels near Punta Carnero, southwestern Ecuador. Distance 2000 yards; highest level 200 feet.

courses, the contour of the main escarpments and erosion remnants, the significance of lagoons, the presence of storm beaches, and finally the general outline of the coast serves to prove that, apart from the lithological nature of the constituent geological formations, the climatic determinant is of great importance.

THE CASE OF THE RIO GRANDE

The surface of the country is intersected by drainage channels of both a primary and a secondary order. A primary watercourse includes usually an extensive system of wide meanders, a section across such a valley being of a characteristic trench-like form, where the corrasion of the valley walls has been rapid yet not sufficiently constant to effect deepening (Fig. 5). The secondary courses are different, being short and steep and presenting a V in cross section. They are common in the vicinity of the coast line, especially in places where the geological formations consist largely of shale or of soft sandstone. The primary drainage courses apparently have been formed under normal climatic conditions, while the secondary channels were eroded during the flood years (compare also the V-shaped gorges in the region to the north where the climate is uniformly more humid). The following observations made by the writer on the Rio Grande during the flood season of 1926 will serve to illustrate the physiographical changes that take place. The Rio Grande has a long and tortuous course (Fig. 1), and the valley is trench-like in section. The heaviest single rainstorm recorded for the year was a little over five inches, and this lasted for eight hours. Within the first few hours

the stream, previously a dry channel, had risen to a height of several feet. Most of the original loops of the meander system were cut into a series of oxbows, or detached islands, and an increasing volume of water flowed with great velocity seawards, the current swinging from side to side with a considerable momentum.

Curiously enough, very little deepening of the original channel was accomplished, yet the lateral corrasion was great. Within the first hour or two the softer shales and sandstones of the valley were

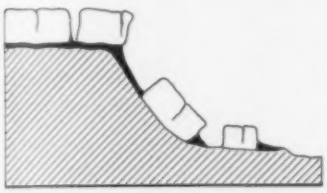


FIG. 4

FIG. 5

FIG. 4—Section of valley wall showing slip of *tablazo* blocks resting on Tertiary sandstones and shales.
FIG. 5—Ideal section of "trench" valley. *Tablazo* (Quaternary) resting upon Tertiary formation.

eroded, and the overlying *tablazo* deposits were consequently undercut and gradually slipped down the steep slope in the form of large detached blocks (Fig. 4).

A few hours later the greater part of the seaward extension of the valley had been converted into a lagoon, or large lake, and the whole of the original meander system was either obliterated or destroyed. At the point of observation the valley had little "fall," and, moreover, the presence of a storm beach, which had been accumulated in past years as a result of wave action, temporarily prevented the flood waters from breaking through to the sea. A few days later, however, the greater volume of the ponded water had found its way through the sand barrier in many places, and thus an intricate delta was formed, with a corresponding waste of detritus which partly obliterated the original river course. The phenomenon, which passed through most of its stages in a few weeks, suggests a possible explanation for the presence of the many large gravel hills that are found in the estuaries of these major river courses. They were formed undoubtedly during flood years and thus furnish additional evidence of the intensity of bygone wet seasons.

VALLEY FORMS IN RELATION TO RAINFALL

It is convenient, at this stage, to give some attention to the steeper valleys that also occur in the region slightly to the north of the one under consideration. Most of the major valleys along the coast sections from Manta southward to Ayangue assume a gorge-like appearance, and several attain a great depth—for instance, the Rio Seco

from Callo to Mipijapa and the small streams that flow between the respective ridges of the Cinco Cerros near Machalilla. These valleys have been eroded deeply through massive Tertiary sandstones and conglomerates; and it is possible that, from their abrupt and truncated appearance at the coast line, they formed in the past tributary valleys to a much larger river which has now been completely drowned. From a study of the valley remnants now seen on Isla

FIG. 6—Type of arid vegetation of the Santa Elena district.

de la Plata, for example, most of which are directed towards the east, it is evident that the V-shaped gorges of the mainland in the same latitude form, or have formed in the past, part of the same drainage system.[5] During bygone times, however, it is reasonable to assume that the general precipitation was greater than at present. As a rule these deeper valleys are formed in a region where there is a heavy rainfall in a drainage or catchment area lying at some altitude above sea level.

In southwestern Ecuador the relative elevation of the land above the sea has been one of the factors that determined whether a river should erode either a steep gorge or a trench-like valley; and, as a rule, it is only when a stream has reached its base level of erosion that the trench form of valley is assumed. There are certain other factors, however, tending to modify the above observations. In the first place, there is a possibility that certain sections of the "litoral" of Ecuador are in a state of gradual tectonic uplift, the result being that the coast is slowly rising in relation to mean sea level. Such being the case, it is evident that the action of a river in deepening its course

[5] George Sheppard: Geological Observations on Isla de la Plata, Ecuador, South America, *Amer. Journ. of Sci.*, Ser. 5, Vol. 13, 1927, pp. 480–486.

will be greatly assisted by a differential uplift of the terrain through which it flows. Where the uplift is developed at a greater rate than the ability of the stream to deepen its channel, the result is a hanging valley. Such valleys are a characteristic feature of the coast line in the vicinity of Machalilla and elsewhere.

Generally speaking, the V-shaped gorges are short in comparison with the long meandering channels of the trench form. They appear

FIG. 7—Tropical vegetation about ten miles to the northeast of Santa Elena district.

to dissect shale country very thoroughly. A section of the coast a few miles to the southeast of the village of Ancon presents one of the most striking examples of a rain-dissected terrain that it is possible to observe in any part of the coast belt. The causes for this are two-fold. In the first place, the superficial formation (a hard, calcareous rock of Quaternary age) has been removed almost entirely by erosion and denudation, with the result that the soft, Tertiary shales are directly subject to the influences of the atmosphere. Shale formations of this type are readily denuded, especially during the flood years, and are thus carved into a system of small drainage channels resembling typical "badland" scenery (Fig. 8).

The greater part of the drainage of this region is indirect, that is the major stream courses head in an opposite manner to the seacoast yet finally enter the ocean by a circuitous course of many miles. The consequence is that the immediate coastal cliffs, a zone rarely more than a quarter of a mile in depth, become deeply channeled seawards, the angle of declivity being sometimes more than forty-five degrees, a direct result of abnormal rainfall.

The "cutting back" process of the existing quebradas takes place during periods of excessive rainfall. Owing to the plastic and almost

impervious nature of the clays derived from the denudation of the Tertiary shale, it has been observed that beyond a certain point—evidently the limit of saturation of the subsoil—no further downward percolation of water can take place. Higher up the valley the rain penetrates beneath the "water-logged" surface clay and actually erodes a subterranean channel upon the surface of the bed rock. By a further development the channel increases in size until finally the

FIG. 8—Badland topography developed in soft shales east of the settlement of Ancon.

roof partly collapses and forms a series of soakage holes from the surface to the solid rock below. These "sink holes" have often a considerable depth and are disposed in lines corresponding to the direction of the underground watercourse. In time the cavities become enlarged until, not infrequently, a series of earth bridges are formed where pairs of contiguous sink holes approach. A final stage in this form of subsurface erosion is completed by a collapse of the earth bridges, with a corresponding increase of length to the original valley. This phenomenon of "cutting back" is characteristic of the country under consideration and occurs only during the severity of exceptionally wet seasons.

MUD FLOWS OF THE WET SEASONS

In rain-dissected areas, under the conditions outlined above, the amount of detritus removed by gravitation alone is enormous. During the cutting back of normally dry valleys the saturated shales and sandstones slip to the lower levels of the ravine; and, as in many cases the slope of the sharply incised valley is considerable, typical mud streams accumulate and gravitate either towards sea level or, in the case of inland valleys, to the level at which the mass arrives at its static equilibrium. An examination of the lithological characteristics of a mud flow is of importance, as not only does it demonstrate clearly the denudatory effect of a heavy wet season upon nor-

mally arid rock surfaces, but it also throws considerable light on curious and puzzling formations found in association with certain Tertiary deposits.[6]

The record of the Tertiary sedimentation in western Ecuador indicates that most of these formations were deposited under varied conditions, ranging from deltaic-fluvial to lagoon; and there is also unquestionable evidence that, during the process of sedimentation of these strata, exceptional phases of flood detritus were included. A typical recent mud flow in this country consists of the following forms of detritus: angular fragments of shale; decomposed ferric, gypseous, and other concretions; blocks of sandstone, varying in size from small fragments to large masses, which have become incorporated in the mud flow by gravitation; thin lenses of foraminifera, washed out of sandstones; and rounded quartzite pebbles. These constituents are embedded in a thick paste or matrix of disintegrated shale and sandstone rocks. The rounded pebbles have been derived from the local disintegration of the Quaternary *tablazos*, which, during the not distant past, covered the greater part of the littoral. It has been noticed on many occasions that gravel patches of sporadic occurrence cover denuded Quaternary beds, especially in the district of Santa Elena. These gravels have been concentrated as a result of disintegration and selection from the calcareous matrix of the *tablazo* rock, this process also being rapid during the flood years. When a mud deposit, formed under the conditions outlined above, comes to rest it either occupies a valley depression or extends in the form of a fan or a solid delta. Its contact with the underlying formations is therefore irregular, but occasionally the surface of these strata has been slightly "planed" as a result of the flow movement.

[6] Charles Barrington Brown and R. A. Baldry: On the Clay Pebble-Bed of Ancon (Ecuador), *Quart. Journ. Geol. Soc. of London*, Vol. 81, 1925, pp. 454–462.

George Sheppard: Further Observations on the Clay Pebble Bed of Ancon (Ecuador), *Geol. Mag.*, Vol. 64, 1927, pp. 227–236.

JOURNEYS ABOUT NAIN

WINTER HUNTING WITH THE LABRADOR ESKIMO

E. P. Wheeler, 2nd

[With separate map, Pl. IV, facing p. 468]

WHILE carrying on geological work in Labrador in 1927 and 1928 the writer was able to gather detailed geographical information which forms the basis for the map of the Nain region that appears facing page 468 of this issue of the *Geographical Review*. In connection with this work he had the privilege of accompanying a number of Eskimo hunting parties into the interior during the intervening winter in search of caribou. During the numerous intervals between trips Mr. Hettasch, the Moravian missionary at Nain, and his wife extended a cordial and understanding hospitality such as one seldom has the good fortune to experience. At these times Mr. Hettasch was of great help in solving the many problems incident to dealing with the Eskimos. Besides being able to speak their language fluently, he could give valuable advice resulting from a keen, unprejudiced judgment and a deep knowledge of and sympathy with them.

The Christmas Season at Nain

With the approach of Christmas the families of Eskimos and settlers began to arrive at Nain from their sealing places scattered for fifty miles up and down the Labrador coast. All were bent upon spending a few weeks in celebration, religious devotion, and the companionship of their fellow men before separating for the winter's trapping. A sudden thaw a week or so before Christmas gave rise to swollen streams that flooded the ice and swept away the early winter snow. The recently frozen pan ice farther from the shore was broken up. Through this wreckage of winter routes the dog teams had to force their way. The family with which I was staying was cut off on one of the islands off the coast. As the mild weather and rain continued, they became desperate and attempted to cross over the shifting pans; but these became smaller and farther apart, and the growing gaps of green water turned them back. Fortunately a slight frost recemented the ice, and the whole party arrived at Nain late in the evening of December 23. Many families had encountered similar difficulties, and some actually abandoned their equipment and came on foot. Yet all were happy to be together again, and none complained of the rough road they had traveled.

In spite of the festival spirit there was cause for deep worry. Only 300 seals had been caught. In a good year they may catch 2000 and use all before spring. A poor catch during the fall hunt means the prospect of a hungry winter. During the winter, seals must be sought among the outer islands far from the mainland in the face of gale after gale sweeping across the frozen shelterless sea from the high interior. Even then returns are small. Most of the Eskimos prefer hunting the bands of caribou that spend the winter on the high treeless plateau whose deeply carved edges form the ragged coast in the vicinity of Nain. When this hunting begins, all other phases of existence are of secondary importance. Food must be eaten quickly and no more often than necessary; camp is made only after it is too dark to go abroad. Sleep is postponed until preparations for the morrow are complete, and it must never prevent an early start in the morning. The Eskimo undertakes these things not as an explorer driven towards a goal but simply as a man seeking his daily bread.

Setting Out for the Caribou Country

After Christmas the pressing necessity for meat turned more than the usual number of hunters towards the caribou country of the interior. I was able to join several of the hunting parties that went in during the course of the winter. On the first I accompanied Martin Martin, a full-blooded, middle-aged Eskimo, and Amos, his adopted cousin. We left Nain on January 18. Freezing weather, following the early winter thaw, had made the surface of the ice as smooth as glass. The dogs could scarcely keep their feet and whimpered like babies. Snow had fallen since the thaw and was piled in hard drifts, over which the sledges had to be hauled. But occasionally we went dashing along, the dogs galloping on top of the drift and the sledge sliding about on the glare ice and caroming from one patch of snow to another.

As darkness approached we came to a house among the trees at the bottom of a well sheltered bay. Although it contained but one room about twelve feet square and already housed five people, we were cordially welcomed. By afternoon of the next day we reached Martin's house at the head of Tikkoatokak Bay, the northern arm of the deep bay north of Nain. This is about twenty miles long and averages two miles in width. It is hemmed in by great hills, many of which are 1500 feet in height. Some maps show one river flowing into this bay, some show none: actually two rivers large enough for canoe navigation enter and serve as winter highways into the interior.

Martin's house was a small frame building about fifteen feet long, made half of poles too small to be called logs and half of badly twisted boards from the little sawmill at Nain. The only window was the gable over the door which had formerly been covered with seal's

intestines sewn together in strips. Here a few days were spent in making the house comfortable for Martin's wife and two little daughters and in assembling equipment for the hunt. Our food consisted chiefly of salt trout and cod. The caribou country was still far away, and there was a shortage of small game; but fortunately we were able to kill a few ptarmigan and arctic hares and a fat porcupine. The dogs were less fortunate and received only an occasional meal of lukewarm flour paste given body by patches of hairy caribou skin and containing a few cubes of seal fat to tempt them.

On January 30 we set out for the caribou country, following the Kamanatsuk, the more westerly of the rivers entering Tikkoatokak Bay. For some ten miles the river wound back and forth in the bottom of a great glacial valley cut a thousand feet into the upland. It was broken only by the rough ice of rapids near the mouth and by a twenty-foot fall a short distance above and was flanked by a fair growth of spruce. In places the ice was flooded and we had to force our way through willows and alders along the banks. Finally the river widened into a narrow lake six miles long that filled the valley bottom. Smooth gray anorthosite cliffs surrounded the lake and extended in places to the water's edge. On the north shore a side stream entering the straight-walled canyon furnished one of the few possible approaches to the adjacent uplands. Unfortunately the stream had burst through some icy dam and poured down to the lake in a flood. Fissures waist-deep were scoured in the snow of the stream bed, and a delta of rubbly snow was heaped up at its mouth. This chaos was in places covered with glare ice and in others cemented into masses as hard and abrasive as slag.

The valley leading to the uplands rose 1100 feet in one sheer pitch. Every step forward required strong effort, and advances were made in stages of a few feet at a time. Above was a gently sloping valley containing occasional ponds and flanked by steep hills. The spruce had become small and scattered, and presently we passed the last twisted and dying group. Here were little fragments of moss embedded in the snow which told us that somewhere in the country there were caribou.

Turning westward again we followed a line of rugged little valleys surrounded by rough hills dotted with innumerable boulders of all sizes. Once we saw a stick of wood leaning against one of these boulders on the sky line, left for a future trip by some returning hunter who was sure of making the timber line before nightfall.

Always we were going up, sometimes gently and sometimes on steep slopes where the dogs required help. As we advanced the hills about us seemed lower, and the white tops of higher mountains appeared between us and the coast. We struck our stride and made no halt for lunch, but thirst stopped Martin near a little pond where he

FIG. 1

FIG. 2

FIG. 3

FIG. 1—Rugged country at the head of Tikkoatokak Bay, beyond which lie the caribou grounds. Kamanatsuk Brook enters through the valley on the left.

FIG. 2—Upper end of Tessialuk on Kamanatsuk Brook.

FIG. 3—Tessisoak on the Fraser River, looking west from the outlet.

knew he could secure water. With a few scoops he had a well of water drawn above the level of the lake by capillarity and kept from freezing by the insulation of the surface layers of snow. Martin knew this pond by experience, but it is said that hunters in the old days could always find water in this way even in parts of the country with which they were unfamiliar.

Now we encountered bits of downhill travel where the dogs could run and everybody could ride. As we crossed a rise of land, Martin would study the slope ahead for a minute and then slip a long loop of walrus hide to serve as a brake over the nose of the runner that he thought would be on the inside of the curve. At times the dogs were scarcely able to keep up with the sledge, and then it required the efforts of two men to prevent it from striking half-concealed rocks. In descents like this the long traces by which the dogs are fastened to the sledges are necessary for the safety of the animals. Though the depression we were following was traceable for at least 20 miles, drainage lines to the Kamanatsuk, whose valley we were paralleling, were beginning to break through.

Two Types of Topography

Finally we reached the dividing line between two types of topography. Behind, the country was wild and rough with mountains extending far into the distance. Ahead was one ridge after another running a little west of north and cut by the trench we were following. The uniformity of the country gave an impression of limitless space. The Eskimos say that behind the rugged coastal region of this portion of Labrador there is a relatively smooth country which they call *sekoujak* (meaning like the smooth fast sea ice along the coast) and perhaps this was the zone of transition between the two. We halted at the junction of two streams at an elevation of 1750 feet. Here, in case of a heavy wind, we had the shelter of a great snow bank which projected from the river bank like an overhanging cliff. The tent, which would have been useless in the high country, had been left standing in the woods near Tessialuk to await our return, and it now became necessary to build a snow house. In place of the snow knife of former times, a crosscut saw was used to cut the blocks; and in less than an hour the crude house was finished—a simple hemisphere, perhaps seven feet in diameter, without sleeping platform or entrance tunnel.

Before supper a large block of snow was drawn into the doorway, and the chinks were filled with snow. The heating effect of the stove, about twice the size of a shoe box, was extraordinary; and the house became so warm that it would not have been considered uncomfortable anywhere. The air did not become foul, because there was a

constant current passing out through the stovepipe which was replaced by fresh air that filtered in through the walls. When the moon rose late that night, the house was flooded with a pale light, and it was some time before I could realize that the moon alone produced this effect. Later I found that the sunlight is so bright in some of the houses that instantaneous photographs can be made of the structure of the snow in the walls.

In the Caribou Country

We had now reached a region where signs of caribou were abundant and fresh; and so it was decided to spend the next day in hunting instead of traveling farther. We started off in the morning armed with a saw, an ax, and a block of wood to use in case we failed to return to our snow house in the evening. As we rode northward up the broad valley with ridges on either side, we climbed occasional hills to examine the country with a field glass. From one of these, three caribou were seen—dull gray spots against the white. They were approaching slowly, grazing on tufts of moss as they came. Since there was no cover Martin had to take a position far in advance and await their approach. As a result they encountered the sledge tracks before they were within good shooting range. The old stag in lead threw up his head and began to walk up and down our tracks sniffing at them. He did not cross the tracks, and presently it looked as if he were going to bolt. Then Martin opened fire. At each shot the caribou would start, run a few yards, and cast a curious gaze in the direction from which the shots were coming. As each one was hit it would drop its head and stand for a while in a dejected attitude. Finally the last one was brought down, and we advanced to prepare our kill for the sledge. The butchering itself is a pretty piece of work. After the skin is removed the fore and hind quarters are cut off and fitted into the body cavity. In this way the caribou is reduced to a solid mass of meat of such a shape that one strong man can handle it.

Now the danger of having to give up the hunt because of shortage of provisions was passed, but we still had to obtain enough to take back to Nain for ourselves and those who had no meat. Martin was constantly on the watch for fox tracks as well as caribou. If he could find a region where both were abundant, he intended to bring his wife and children to these barren uplands, establish them in a snow house, and spend the rest of the winter trapping. But except for caribou tracks there were no signs of life in the country. Jays and chickadees had vanished with the woods, and even the ubiquitous raven had failed to appear, though we saw him occasionally on subsequent trips. It was a land frozen into immobility. Even the gale blew in silence. To attempt to describe the country is to condemn it, yet its vastness and

somber strength give it a fascination that no more congenial region can equal.

Most of the meat was left in a pile to be picked up later, and we set off in search of more caribou. When we were about to turn back we saw a band on the slope of a ridge ahead of us. Five we shot, and of the two survivors one was brought down by the dogs that had bitten

FIG. 4—View across west end of Tessisoak on the Fraser River showing main river valley cut to sea level in 1500-foot plateau (*sekoujak*).

through their traces and joined the hunt. There was no time to skin the animals; a knife was driven into the paunch, letting out the contents of the stomach, which served the double purpose of reducing the space occupied on the sledge and keeping the meat from spoiling.

RETURN FROM A SUCCESSFUL HUNT

Camp was not reached till long after dark, when a deep hole was dug in the floor of our snow house and all but one of the caribou were tumbled into it. The remaining carcass was chopped up and given to the ravenous dogs. The Eskimos were wise enough to postpone their own celebration until the following night after an easy day spent in bringing in the rest of the meat. Then the taciturnity of previous anxiety disappeared in talk and laughter.

In the morning it took all the efforts of the men and the dogs to put the heavily loaded sledges in motion. But by the time the first upgrade stretch was reached the dogs had worked off most of the sluggishness resulting from heavy eating. On reaching the crest we encountered the full force of the gale that had sprung up during the night. The drifting snow, like a heavy fog, blotted out the sky. Fortunately the wind was out of the west as usual, so our backs were towards it. Struggles to avoid disaster on the downward grades were almost as severe as those encountered in the ascent, and the strain on the nerves was far greater.

That night we camped at the tent we had left standing on our outward journey, and the next day we reached Martin's house. Up to this time Martin and Amos had shown phenomenal endurance. Now that the job was done they seemed to collapse. All movements became languid, and they sat about without even talking. It was late the next morning before any one was astir, and the day was spent

FIG. 5—Typical high country just north of head of the big lake on the Fraser River.

in idleness. After this rest we set out for Nain with a large part of the meat. Again the wind was raging out of the west, and the bay was hazy with drifting snow. Preparations were made to sail the sledge where possible. At the house of Simeon, where we had stopped the first night out, Martin left a quarter of meat in appreciation of his hospitality. When we reached Nunaengoak, the bay north of Nain, the wind was favorable, and a square sail of burlap was hoisted. Our pace was so rapid that the dogs could scarcely keep ahead of us. As evening came the wind grew stronger, and the sledge twisted and turned on the smooth glare ice. Finally it capsized, and the sailing came to a sudden end. The rest of the journey was made at the more sober pace set by the dogs.

On reaching Nain a large part of the population of the village turned out to help us unload. Though people were delighted by our large load of meat, we should have received the same attention had we returned empty-handed. The reception that the Eskimo give a traveler is one of the most delightful customs of this attractive people.

MORE HUNTING PARTIES ORGANIZED

The next day there was a great deal of activity in the village. Now that it was known where caribou could be found, a number of hunting parties were organized, and all were busy with plans for immediate departure. Martin had given away most of his meat and

was ready to take part in a new hunt. Again I accompanied him. As before, we spent our first night at Simeon's house—this time so crowded that there was hardly room to move.

Departure in the morning was delayed by loss of some of the dogs who had slipped their traces. It was noon before we started, and a little later we were overtaken by Evalde, Martin's special partner in many ventures. He was traveling fast with the small load of a lone hunter. By combining teams and putting everything on one sledge we were able to proceed at a decent pace. We followed a roundabout way past the mouth of Tikkoatokak Bay. Here the ice was as rough as a plowed field, with blocks heaped into hummocks and ridges as a result of heavy tidal currents. In the center of the chaos and almost concealed by the rough ice lay a great black patch of water that remained open all winter. Treacherous places such as this are not uncommon along this coast where the tide flows through many channels to the long deep bays beyond. From here we made our way to the snow house built on our previous trip, where we were joined by Johannes, a young man whom we had seen in Nain. He brought me a pair of caribou skin mittens that his mother had made for me. Caribou skin is the most satisfactory material for outer clothing, since frost from body moisture does not collect in garments of this material as it does in those of cloth or sealskin.

North in Search of Larger Herds

Instead of hunting from the old camp we decided to go farther to the north in search of larger herds. Throughout the march of the following day the rolling character of the country remained the same. Though our route followed the caribou tracks, we saw only one herd during the first day. It was a long way off and already in flight. As we were about to stop for the night Evalde spied a caribou feeding on a distant hillside. Martin and Evalde went after it while the young men made camp. The pale green sky had turned black, and the northern lights were flickering overhead before the hunters returned with the news that there were many caribou about and that they had killed a number of them. Here we were joined by Jaco, an elderly Eskimo of the old school.

The next day we hunted in a great circle from camp, returning by way of a basin several miles wide flanked by numerous ridges that looked exactly alike, with great overhanging banks of snow at the ends. Our camp was just around the corner of one of them. Suddenly the wind swooped down, and drifting snow had blotted out the hills and landmarks. Martin, calmly standing on his sledge and peering in search of something to point the way, finally detected faint tracks that we had made the day before and brought us back.

The rising storm brought warm weather with it. It continued unabated, and we spent the following day napping and mending equipment. The quiet conversation was hardly more than a murmur of contentment. One day of such idleness was very welcome as a rest; but on the second day every one began to fidget, and by noon Martin and Jaco decided to venture forth into the blizzard and hunt on foot. The wind had turned bitterly cold, and the snow was blinding. All that we could see was an occasional black ledge protruding through the snow. It was evident that we were following a network of valleys. In one of these we found fresh tracks, and soon we almost stumbled over two caribou, only one of which was killed. We saw no more caribou tracks and soon turned back to camp. On the way the wind dropped, and the landscape became visible once more. Two dogs passed us, hunting on their own account. They were too intent on the hunt to hear, even when the Eskimos raised the food call. When not in harness the dogs are allowed to roam free about the camp, and the food call is used to bring in those that have strayed. Because of its effectiveness, it has many other uses.

In the late afternoon the other hunters went out with their teams to bring in the carcasses, while Martin went to a bare shoulder of the hill above camp and built a small cairn as a landmark for anyone crossing the basin where we had lost our way several days before. Such cairns are encountered in various parts of the desolate high country. Some were built so long ago that lichens fill the cracks between the stones. Their peculiar shape and their location on eminences where snow seldom collects make them visible against the sky line for many miles as guides for travelers through the trackless waste.

Return for Celebrations at Nain

It was now decided to return for the pre-Lenten festivities that had begun at Nain on February 17. Before leaving, the meat was divided, each man's share depending not on what he killed but on the strength of his team. The heads, which are considered the choicest meat, go to the man who makes the kills. One carcass, killed far from the line of march, had to be abandoned. Of all the caribou killed by the hunting parties I joined during the winter, that was the only meat wasted so far as I know. The Eskimos may be merciless killers, but they need all the meat they can get and will work to exhaustion to bring out their whole kill and share it with their less fortunate friends.

The temperature was moderate, and the leaden sky added to the monotony of the scene. Late in the afternoon snow began to fall through the still air. The storm kept up through the night, and the next day the freshly fallen snow made traveling slower than ever. When we came to the steep drop near Tessialuk Lake, we took the

sledges down without unloading them. In the worst places it required three men on each side of the sledge. Camp for the night was made near the outlet of the lake. During the night the flood water rose, and it required most of the day to make the few hours' run to Martin's house. Martin remained at home an extra day. The others were eager to reach Nain in time for the celebration for unmarried people.

Much of the coast is fringed by a zone of ice that tidal action has forced into ridges made up of jagged blocks. Over reefs, these fringes of ice extend some distance from the shore. Darkness found us on such a patch about eight miles from Nain. A gale was blowing, snow was falling, and the darkness was so intense that even our dogs were invisible. In the center of the bay much of the snow had been blown off, and on the patches of glare ice the dogs were almost helpless against the force of the wind. Finally we abandoned the sledge and made our way on foot to Nain.

This hunt was followed by some weeks of inaction. First the Eskimos were assembled to hold their celebrations. Then there was an epidemic of colds brought in by the winter mail. There were no fatalities, but a deep depression and melancholy lasted long after the symptoms of sickness had disappeared. Finally, on March 22, a motley company of hunters including Martin and Evalde set out with very light loads. By this time meat was so scarce that nobody had more than half a seal.

On this trip the country north of Prichard's Frazer River was the goal.[1] By the second day we reached the big lake. The sun was warm and traveling good, and by the end of the following day we were in the high country north of the lake. Here the party divided, apparently as a result of a struggle for leadership between Martin and Isaac, an older Eskimo of a very domineering character. Finally Martin and Evalde turned onto the plateau, while Isaac drove down a valley accompanied by the rest of the hunters. That night we were unable to find a sheltered camping place and finally built a cold, drafty house in the granular snow just above the surface of the ground. The next day Evalde alone shot eight deer, and it was decided to return immediately. We took a new route to the Frazer River that Evalde had seen once many years before and that Martin knew only by hearsay. As we approached the great cut that forms the river valley, we found ourselves in a maze of little upland valleys that completely cut off our view. We followed the most promising-looking stream. This rapidly cut deeper into the high plateau and walled us in completely. Night came before we knew whether or not we had chosen the right valley. The next morning we started out in a wet, heavy snow-

[1] H. Hesketh Prichard: Through Trackless Labrador, New York and London, 1911. The location of the mouth of the Frazer River was determined, and its course followed, by H. Hesketh Prichard in 1910.

FIG. 6

FIG. 7

FIG. 8

FIG. 6—Spring hunting camp in timber of Kingurutik Brook. Men scraping sledge runners. Snow house, bough shelter, and tent all in use.

FIG. 7—Upper reaches of Kingurutik Brook and adjacent uplands. Snow beginning to melt off in the spring.

FIG. 8—Martin's family leaving for the spring seal hunt. All are wearing snow goggles.

storm. One man had the task of handling the two teams of dogs, each of which was hitched to two or three caribou carcasses tied together in tandem. The other two men handled the sledges. The final slope down to the lake was the steepest that we had encountered and was covered by a solid sheet of ice. Even the dogs had to be shoved over the edges. The soft new snow made travel slow and heavy even on the lake and slowed down our return.

Last Hunt of the Season

The final hunt of the season started on the first of May. This time it was led by Mike, an old but skillful hunter and traveler. Kingurutik River, the larger river entering Tikkoatokak Bay, was our destination. The second morning we were off by five o'clock in order to take advantage of the night frost that had frozen the ice of the big lake near the mouth of the river. Before noon it was beginning to thaw. We decided to make our permanent camp among the trees of the valley bottom, where Mike had cached some meat on a previous hunt. Now that the days were longer, we hunted twelve and fourteen hours a day.

The valley that led to the uplands was interrupted in one place by a fall about fifty feet high, an awkward place to negotiate. Sledges heavily loaded with meat had to be lowered by a sealskin line. Though caribou tracks were abundant, hunting was not good. Finally, two big killings concluded the hunt. Up to this time there had been occasional days of rain that made the Eskimos study the river thoughtfully. All the snow had vanished from its surface, and water was beginning to run on top of the ice and gather in pools. Most of the rapids were undermined or entirely open, and near the mouth of the river some of the ice was too rotten to support the weight of a man. In places we even had to lay skids in order to take the sledges over the bare ground of the river banks. The seaward half of the big lake above Tikkoatokak was flooded knee-deep with water and slush. May 12 was our first day of real spring; and, despite snow on the ground, blowflies came around the meat during our noon halt. At the head of the bay we were greeted by the first gulls, ducks, geese, robins, and mosquitoes of the season. The ice in the center of the bay had sagged and was flooded with blue water on which gulls were swimming. But, except for the deep channels cut by the ebbing tide, traveling was good near shore.

This was the last caribou hunt of the season. Though Martin tried once more to go inland, he was unable to get beyond the head of the bay and had to return empty-handed. After that, he waited for the water to drain off the land ice. Then, like most of the people of Nain, he filled a small boat with his possessions, put it on his sledge

with his family on top, and went to one of the outer islands to pitch his tent and begin the spring seal hunting.

APPENDIX: NOTES ON MAP OF NAIN REGION

In carrying on the field work connected with the map of the region about Nain (Pl. IV) the principal instrument used was the Brunton compass, both for taking bearings and for establishing a triangulation net. Work was much hampered by the many areas showing marked local deviation from the normal declination of the region. This was not uncommonly as much as 5° and in some cases reached 15° or 20°. The declination as given on the British Admiralty harbor chart of Nain[2] was accepted as correct, and the meridian was carried from there through much of the area mapped by reverse bearings. Also bearings were taken on three known points as often as possible, so that resection could be used as a check in determinations of local deviation. It was found that the local deviation from the normal declination of the region at any point was likely to be proportional to the height above sea level and the steepness of the topographic relief in the vicinity. Thus the declination was often normal near the shore line where the relief was not too great. This fact was used quite frequently when the chain of reverse bearings and resections was broken; and, if a series of several bearings and reverse bearings in such a region checked closely, the declination was considered normal there. Determination of azimuth by astronomical means was not attempted except for an occasional rough bearing on the sun during noon latitude observations.

In the triangulation net established about Nain the base line consisted of three hilltops near that village forming a triangle whose sides average about three miles. Their position was taken from the harbor chart mentioned above. The net extends out from Nain to the mouth of Kingurutik Brook and northward along the coast to the head of Webb's Bay. In addition certain isolated points—as Mt. Thorsby, Alagaiai, and Amerak—were included and used as points of reference in mapping the adjacent country. Finally, bearings on triangulation stations were taken from a summit of the Kiglapait Mountains and several summits in the Angutausugevik drainage basin as rough checks on the surveying in this northern section. At times the height of a hill as determined by aneroid was used as a base line in the triangulation of small areas along the coast and among the outer islands. Vertical angles were taken with the Brunton compass in this work. Some of them were as small as 2°, but the resulting distances checked reasonably well with those obtained by time and estimated rate of travel in a canoe.

This time-rate method was the one relied on for direct determination of distances in auxiliary traverses through the triangulated area and was the chief method of surveying throughout the remainder of the area. Rate of travel by canoe, by dog sledge, and on foot were all used. The first of these was apparently the most accurate and was employed far more than either of the others, while rate of travel on foot was avoided as far as possible.

Sextant observations for latitude and longitude were occasionally made throughout the area, and the results were used as a check on the location of points by other methods. Errors of several minutes may occur in individual determinations as indicated by differences between several observations at the same point. The magnitude of error was the result of lack of experience in the taking of observations and the use of makeshift artificial horizons. The results of longitude observations were further vitiated by the fact that only one watch was used and that it was subject to occasional erratic changes of rate. Radio time signals were used to detect these

[2] Sandwich Bay to Nain, Including Hamilton Inlet, 1876, Large Corrections July 1881, *British Admiralty Chart 375*.

changes whenever possible, and over some time intervals satisfactory results were obtained. However, on some of the longer trips out from Nain several changes of rate appear to have occurred, and the whole series of longitude determinations for the trip had to be discarded. The basis for rejection of astronomical observations was the occurrence of large discrepancies between the observations themselves at a given point or near-by points and of unreasonably large differences between the location of points by astronomical methods and surveying methods. Smaller differences were averaged, an effort being made to weight each value in accordance with the degree of accuracy of the method by which the point had been located.

The vertical control depends on traverses made with an aneroid barometer having scale divisions of fifty feet. Wherever possible these traverses were closed by observations at sea level or at points of previously determined elevation at least once and sometimes several times during the day. In the interior where there was no base of known elevation from which to work the camp was used as a reference point. Here morning and evening readings were taken on the barometer, and its elevation was calculated from the differences between these and simultaneous readings made on a mercurial barometer at Nain. Comparison of such readings taken at sea level in various parts of the area mapped indicates that elevations obtained in this way are not in error by more than one hundred feet; and where a number of observations have been averaged together the error should be much less.

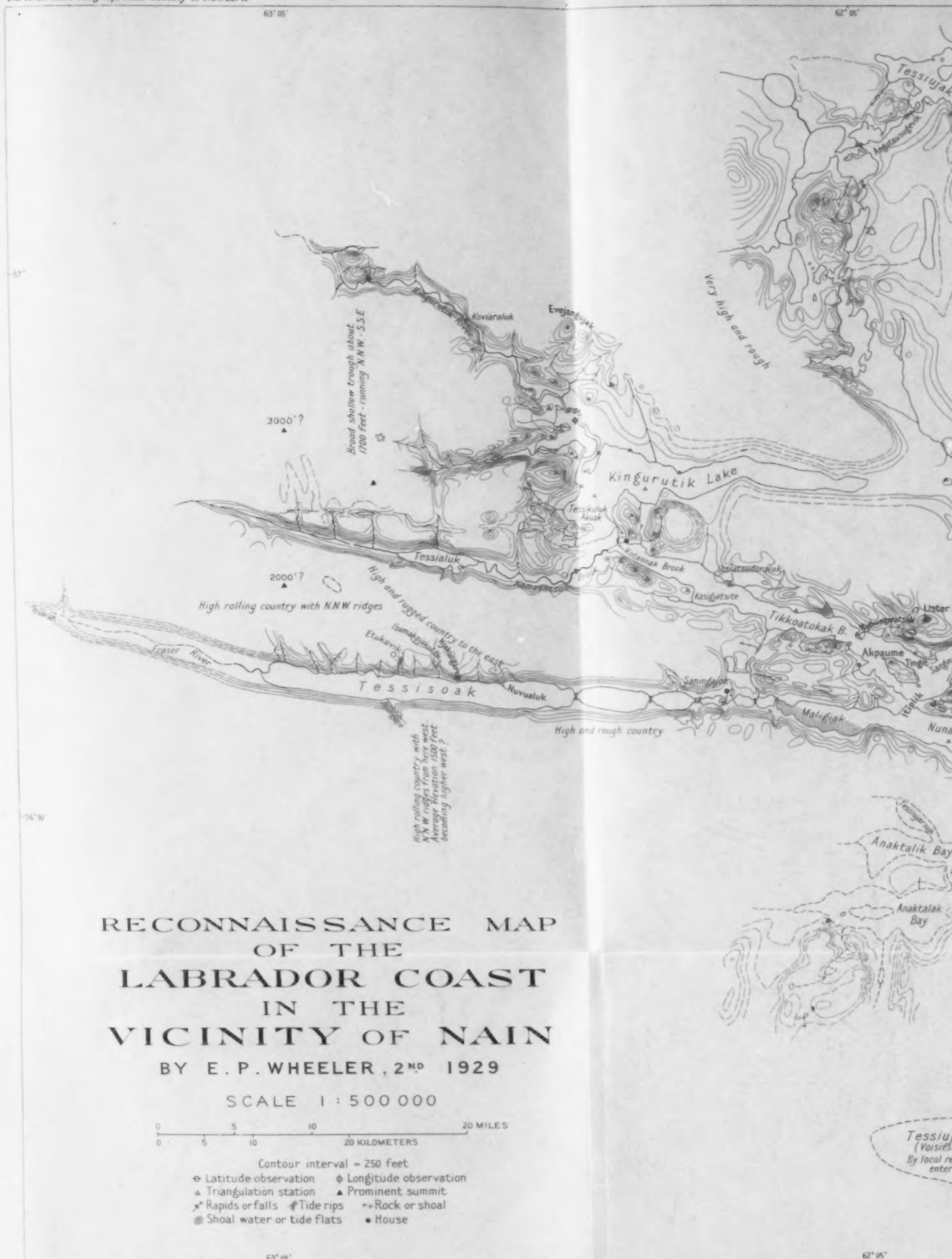
Rectangular projection was used in preparing the field maps, which were drawn to a scale of 2 miles to the inch and with a contour interval of 250 feet. The final map was drawn to the same scale, but conic projection was used, the cone being tangent at latitude 56° 45′ N. On this final map some general features were taken from the British Admiralty chart referred to above for the sake of completeness. Also details were amplified to a greater or less extent, in some cases photographs being used. On the other hand quite a number of small islands have been entirely omitted because of insufficient data for the determination of their position and shape.

Amplifications were chiefly in the contouring. As the number of elevations determined was comparatively limited, much free-contour sketching was necessary even on the field maps. Thus, in general, the contouring cannot be considered as giving anything more than a rough indication of the nature of the topography, though the height and location of many of the main summits are correctly indicated.

In place names, local Eskimo usage has been followed as far as known to the writer, European names being given also in all cases where they could be learned. In the orthography of Eskimo words an effort has been made to follow that of the Moravian missionaries of the region, whose predecessors introduced writing to the Eskimos. As a result the characters have the German values to a large extent. The Eskimos themselves do not spell uniformly or correctly, so that the missionaries were consulted in the spelling of many names. In the case of others an effort was made by the writer to spell the names from Eskimo pronunciation, using the same values for the characters. Many of these may be incorrect because of lack of knowledge of the grammar of the language and an insufficiently trained ear. Finally, the spelling of certain names, though not entirely correct, has been taken from the British Admiralty chart. In this case the differences are slight, and the names are those of such prominent features that their spelling is in comparatively wide use already and a change does not seem advisable. Chief among these is "Kiglapait" which, if correctly spelled, should be "Kiglakpait" according to Bourquin.[3] No distinction has been drawn between the two values of "k" on the map because there are too many cases where the writer is uncertain as to which is correct.

[3] Theodor Bourquin: Grammatik der Eskimo-Sprache . . . an der Labradorküste. 1891, p. 260.

The American Geographical Society of New York



RECONNAISSANCE MAP OF THE LABRADOR COAST IN THE VICINITY OF NAIN

BY E. P. WHEELER, 2ND 1929

SCALE 1 : 500 000

0 5 10 20 MILES
0 5 10 20 KILOMETERS

Contour interval = 250 feet

⊖ Latitude observation ⊕ Longitude observation
△ Triangulation station ▲ Prominent summit
Rapids or falls Tide rips +· Rock or shoal
Shoal water or tide flats • House

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LAND UTILIZATION IN THE SANTA LUCIA REGION*

John Wesley Coulter

THE Santa Lucia region, an area of some 3000 square miles on the coast of central California, is a marginal land. Rugged topography, isolation, and scant and variable rainfall conspire to make difficult the problem of earning a living therein. About one-fourth of the area, situated chiefly in its more rugged, more isolated part, is unused. Most of the used land is devoted to cattle ranching; some border areas to dairy farming, to general farming, and to dry-land wheat farming; and a few widely separated peripheral areas of restricted extent to intensive agriculture of specialized types. In addition to grazing and agriculture, a little lumbering and mining are carried on. The economic activities pursued on some three-fourths of the used land are on the border line between success and failure. Essentially all of the scattered lands that are used with distinct profit are on or near the limits of the region; though *in* the region, they are not characteristic *of* it.

The Santa Lucia region consists chiefly of two of the coast ranges of California, namely, the Santa Lucia Mountains and the San Luis Mountains. Several of the structural valleys in the mountains afford considerable areas of relatively useful land; most of the valleys formed by stream erosion are narrow and steep-sided, and many of them are of the canyon type. The soils upon the mountain sides are prevailingly thin. Steep slopes and thin soils preclude the cultivation of most of the land, which can be used, if at all, only for grazing.

The ruggedness of the mountains and the striking paucity of the passes in the ridges make the construction of highways difficult and expensive, especially along transverse lines. The northern four-fifths of the region is not traversed by a railway, and in much of it mountain trails are the only routes of travel. This isolation is emphasized by the character of the coast line and the offshore waters. For 80 miles along the northern part of the coast the rugged nature of the shore, many submerged rocks, large beds of kelp, and the prevalence of fogs prevent the safe approach of ships. The coast of the southern part of the area is not so formidable a barrier to communication as that in the northern and central parts, and here there are two small ports.

The average annual rainfall at sea level ranges from a minimum

*This study of land utilization in the Santa Lucia Mountain region is based almost entirely on field work done during the summers of 1921, 1923, and 1925.

FIG. 1—Relief map of the Santa Lucia region and contiguous area. Contour interval 100 feet. Scale approximately 1 : 1,700,000.

of 15 inches in some localities to a maximum of about 21 inches in others. The precipitation at inland points varies within somewhat greater, but unrecorded, limits, with altitude and especially with exposure.[1] Not only is the rainfall light in all parts of the region, but the amount received in successive years sometimes varies considerably, and there is always uncertainty as to when the rainy season will commence. It usually begins in November, but sometimes that month is dry.

The people of the Santa Lucia region number about 21,000, more than half of whom live along or near the coast in the southwestern part of the region. The population is about evenly divided between

[1] Cf. Forrest Shreve: The Physical Conditions of a Coastal Mountain Range, *Ecology*, Vol. 8, 1927, pp. 398–414. He says "The heaviest rainfall is along the coast opposite the highest part of the mountains, being 34.23 inches for Big Sur" [1918–1925].

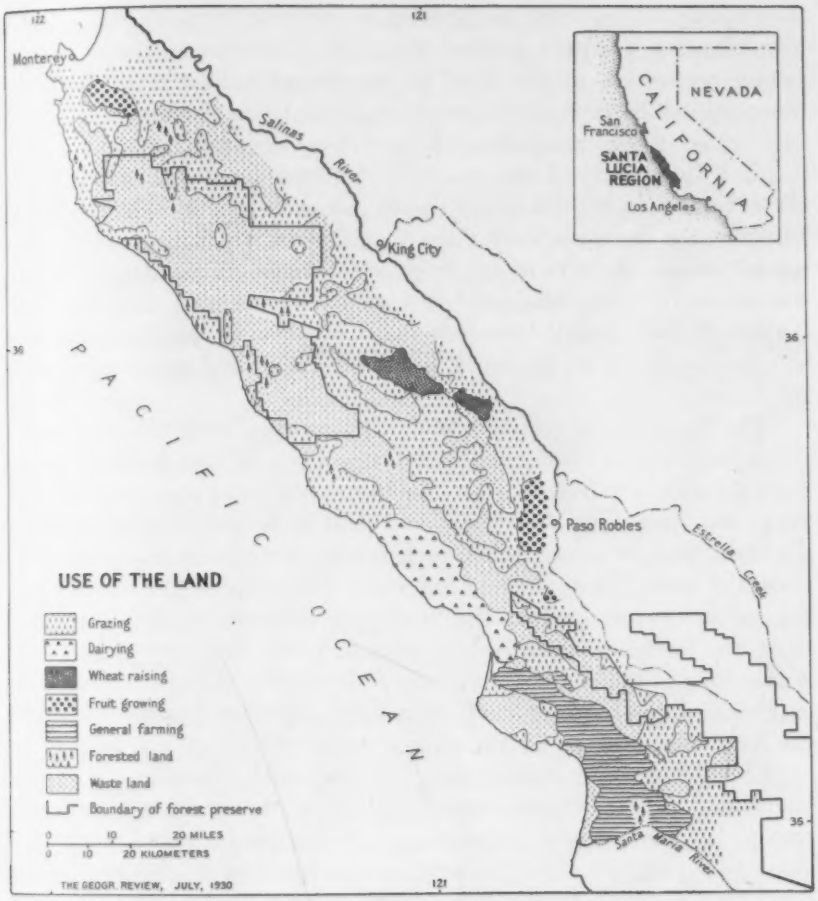

FIG. 2—Land utilization map of the Santa Lucia region. The inset shows the location of the region in the state.

rural and urban groups; nearly all the urban communities are in the relatively densely populated southwestern section.

BEEF CATTLE RAISING AND DAIRY FARMING

About one-seventh of the population derives its support from the raising of beef cattle. The grazing lands, irregular in shape and separated by unused tracts, are scattered throughout the entire region and occupy about half the total area. About nine-tenths of the cattle depend solely on natural pasturage; and a subnormal rainfall, if at all pronounced, causes a serious diminution in the amount of available feed.

The larger units of land devoted to cattle raising are areas that were granted by the Mexican government to settlers who used them

for grazing. They vary in size from about 7000 acres to 40,000 acres. The Mexican grantees secured the richer pastures in the region by taking possession of the land in the larger valleys and along the more accessible parts of the coast; on these lands also water for cattle was rather easily available. Soon after California became a state in the Union, many of the grants in this area, as in other parts of the state, were sold by the Mexicans to American settlers; in the Santa Lucia region there are only a few instances in which these lands have passed on to the heirs of the original grantees. Less attractive land was settled in homesteads of 160 acres by people who started to raise cattle. It was found, however, that 160 acres of poor grazing land was too small a tract on which to earn a living, and many sold out to neighbors.

The Santa Lucia region is about halfway between the two largest cattle markets in California, San Francisco and Los Angeles, and is visited by buyers from both. The location assures more competition between buyers, and therefore prices tend to be somewhat better than are obtainable in many other stock-raising sections in the state. The season of most abundant and luxuriant pasturage in the Santa Lucia region, moreover, enables the stockmen there to market the cattle when the demand is relatively great and prices relatively high. Notwithstanding these two advantages, however, in recent years the expenses of the average cattleman have exceeded his income under the handicap imposed by the natural environment.

The stockmen in this region, together with those in the rest of California, have suffered financially since the war and have not regained their pre-war prosperity. Although California does not ship cattle to markets farther east, as is the case in neighboring states, the prices of cattle in adjoining states have a direct effect on cattle prices in California. The transportation differential from potential sources of supply for Los Angeles and San Francisco markets is so small that, should the price per pound in California rise but a fraction of a cent above that in neighboring states, these states would help to fill the demand and would continue to do so until the California price fell again. Some stockmen are moving out of the region, and their ranches are being combined with others into larger units.

The raising of hogs in the Santa Lucia region as part of the system of farm economy is practiced by some stockmen; this is especially the case among those in the isolated coast district. During the greater part of the year the herds, which commonly number from forty to fifty animals, feed on mast, roots, and grasses; these natural foods are supplemented by barley, on which the animals are fattened for market. The steep, rugged character of the coast in this district makes necessary special facilities for loading hogs for shipment. Landing cables along which nets slide are commonly used.

The raising of certain crops because of the difficulty in obtaining provisions in the isolated coast district is an aspect of farm economy that also distinguishes stock ranching there from ranching in other parts of the area. Vegetables raised for home use include corn, tomatoes, beans, peas, and potatoes. The arable land is confined to narrow coast terraces and to small areas of more gentle slope on the mountain sides.

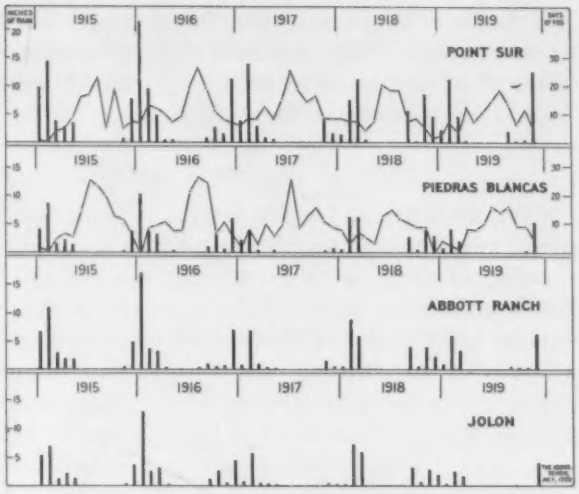

FIG. 3—Rainfall records at typical stations in the Santa Lucia region. Number of foggy days is also shown for two of the stations.

In spite of the difficulties confronting stockmen in the Santa Lucia region, cattle raising is the best use to which most of the used land can be put.

In an area of about 50 square miles along the coast northwest of San Luis Obispo some 1200 people are supported by dairy farming. The dairy-farming district comprises most of the northern part of the hilly area lying along the southern coast of the region between the main ridge of the Santa Lucia Mountains and the ocean. This occupation has been described by the author in a recent number of the *Geographical Review*.[2]

WHEAT FARMING

Two small areas in the east-central part of the region, having a total population of about five hundred are devoted primarily to growing wheat by dry-farming methods.[3]

The yield of grain from year to year is uncertain because of the variation in the rainfall. In general, a crop can be grown on the same land only once in two years because of the restricted supply of moisture in the soil, and even two years of subnormal rain may bring the farmers to the verge of ruin. The hazard is increased by the fact that farmers have been following a one-crop system so long that the fertility of the soil has been considerably reduced.

[2] See "Contrasts in Dairying in Two Dissimilar Areas of the United States," by J. W. Coulter, *Geogr. Rev.*, Vol. 17, 1927, pp. 605–610.

[3] J. W. Coulter: A Critical Situation in Two One-Crop Wheat Farming Districts in California, *Econ. Geogr.*, Vol. 5, 1929, pp. 87–97.

So far as physical conditions in these districts are concerned, the farmers can advance to mixed farming instead of retreating to cattle raising. The inevitable change in farm economy may be facilitated and in some measure shaped by the construction of a proposed irrigation reservoir in the upper part of the San Antonio Valley. The availability of water for irrigation might well result in the raising of alfalfa and other feedstuffs for dairy cattle. The keeping of more stock would assist in the upbuilding of the depleted soils. Diversified and more intensive agriculture will tend to increase the population capacity of these districts.

Fruit Raising

In two areas of foothill land on the eastern margin of the region about one thousand people are engaged in raising fruit. The successful growing of almonds on a moderate scale in the foothills of the Santa Lucia Mountains encouraged a company project to convert to almond culture large tracts of land previously devoted to the production of grain or cattle. Young trees were planted on about 800 acres in the Santa Lucia foothills and on about 15,000 acres to the east of the Salinas River. The new farms, 10 acres in area, are so small that, even with a good yield, a sufficient quantity of almonds cannot be raised to make the business pay. The land recently planted was sold under the instalment plan; it has not been settled, and most of it probably never will be. If in future more orchards are planted, great care should be taken to choose appropriate sites, particularly as regards soil and air drainage.

In the other foothill area, Atascadero, the efforts of fruit growers have resulted in failure because the lands used were in no sense suited to the purpose. Attention seems to have been focused almost wholly upon the soil ignoring, among other things, the climate; and owing in large part to insufficient moisture the fruit trees that were planted have failed to produce as expected.

In contrast one sees successful fruit growing in the peripheral area of the Carmel Valley. The appearance of the fruit farms, with their neat, well kept houses and gay flower gardens, is indicative of prosperity; and the enthusiasm and confidence of the owners are refreshing to the observer who has been depressed by the situation in the Paso Robles and Atascadero districts. So far as can be seen, the growing of pears will continue to be profitable at Carmel; but the industry can expand but little, since all of the land suited to the purpose is already in orchards.

General Farming

An irregular area of hill and valley country to the west and south of San Luis Obispo, lying between the southern part of the Santa

FIG. 4—The Santa Lucia region. The Mexican land grants for grazing are shown by shading. Railroads are shown by conventional symbol, state highways by double line, other roads by single line, trails by broken line.

Lucia Range and the ocean, supports about three thousand people. General farming is the type of agriculture carried on. The district has a heavier rainfall than farming districts in the interior and on the east side of the mountains, and for the most part the heavy fogs of summer have a beneficial effect.

In contrast to the northern four-fifths of the Santa Lucia region, within which there are no railroads and few good highways, this district is served by two railroads, a state highway, and numerous good county roads. These means of communication not only facilitate

the marketing of crops but enable farmers to keep in close touch with one another to their common benefit.

The district of diversified agriculture is the most densely populated part of the Santa Lucia region. It contains two small towns and four villages. The city of San Luis Obispo, near its northern border, is the trading center for many of the general farmers. Most of the people live in the lowland areas, and the intervening hills and uplands are in comparison sparsely populated.

The character and distribution of the various crops raised in the general farming district depend on a number of factors, many of which are environmental. In the case of sugar beets soil fertility and freedom from gravel are very important factors. With alfalfa the practicability of irrigation is the first consideration. In the case of vegetable crops the richness of the soil and ease of working it are matters of importance. On the other hand the large production in one part of the area of beans as a crop in a regular rotation series is in large part due to the initiative and leadership of a single farmer. Elsewhere the inclination of farmers of Portuguese extraction seem to account for the importance of bean cultivation. In some instances a farmer puts a large part of his effort into the production of one crop or commodity because of nearness to a local market or to a railroad. Near San Luis Obispo, for example, special emphasis is put on dairy products. The possession of suitable land near the Pacific Coast Railway is an incentive to some owners to specialize in the production of sugar beets.

In all parts of the general farming district some crop rotation is practiced. In many cases, however, no regular system is followed. Thus beets may be raised on the same land for several successive years, and when the yield becomes appreciably smaller, beans may be substituted for a number of years until the farmer concludes that the soil has been sufficiently enriched to warrant putting the land in beets again.

Widely separated peripheral localities devoted to truck farming, to grape farming, to flower and bulb farming, and to poultry farming are prosperous and apparently stabilized.

Lumbering and Mining

Lumbering is not a profitable industry in the Santa Lucia region. The time and methods of logging are closely related to the peculiar environmental conditions. The work is carried on, for the most part, during the dry season, as the condition of roads and trails during rainy weather makes hauling difficult and at times even dangerous. The stands of timber, restricted in size, are situated in scattered, isolated localities, and accordingly operations must be transferred at

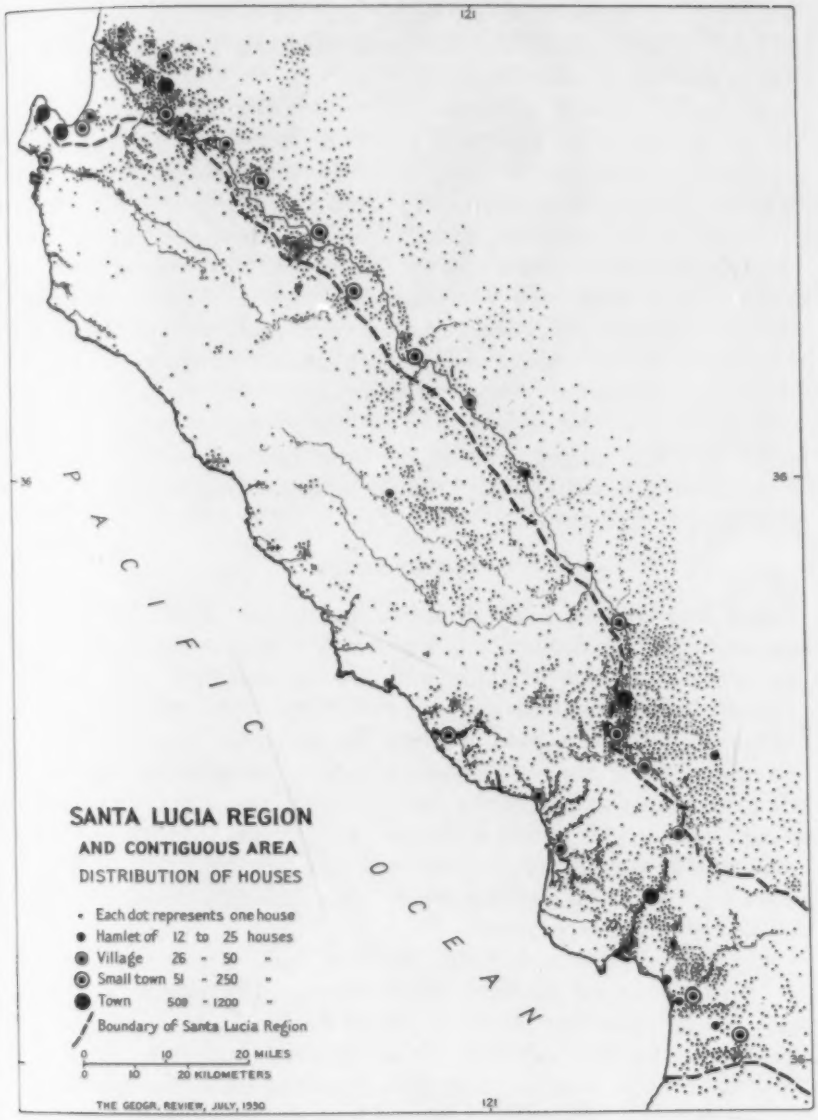

FIG. 5—Distribution of population in the Santa Lucia region and contiguous area.

frequent intervals to new locations. The work involves merely the "skinning" of certain canyons whose resources will presently be exhausted.

Mining has been carried on in a small way in the area in scattered isolated localities where there are bodies of cinnabar and chrome iron ore. The scattered deposits of these minerals are still considerable. When, sooner or later, the prices of quicksilver and of chrome ore

warrant, the deposits of the region will be worked again. Periods of activity and periods without production may alternate repeatedly before the deposits are exhausted.

A little oil mining is carried on at the Tiber Oil Field. This field lies on the line of the Southern Pacific Railway, and the oil is sold to the railway company for fuel. Several ventures in drilling for oil in other parts of the region have proved unsuccessful.

Most of the land not included in the areas specified above is unused. By far the greater part of it is in the Santa Barbara National Forest. This land may very possibly come to have increased significance presently, since there are eight sites in the valleys of mountain streams fed by its run-off, upon which dams for irrigation reservoirs could be constructed. Most of the land which could be supplied with water from the reservoirs is outside of the region, but some is within it. The rugged lands in the heart of the mountains, of little or no direct economic utility, should be retained permanently in the national forest system.

Settlements

San Luis Obispo, a city of about 7000 people, is much the largest community of the Santa Lucia region. The city owes a considerable part of its activities to trade with the surrounding country, especially with the general farming district to the south and the dairying district to the northwest. Among the activities closely related to the conditions of the surrounding country, the retailing and wholesaling of supplies of all kinds are of importance, the city supplying villages and towns within a radius of 25 miles. There is also an important butter-manufacturing industry based on the supply of cream from farms in near-by areas. San Luis Obispo is the seat of the county of the same name.

San Luis Obispo would not, however, have attained its present size were it not for external relationships. The city is a division point on the coast line of the Southern Pacific Railway and has car repair shops for that railroad. It is the headquarters of the Pacific Coast Railway, a narrow-gauge line operating in a rich agricultural country between Port San Luis and Los Olivos in Santa Barbara County, which adjoins San Luis Obispo County on the south. The city is on the route of a pipe line between oil fields in the San Joaquin Valley and Port San Luis and is a local headquarters for the Union Oil Company. And finally, San Luis Obispo is on the coast highway between San Francisco and Los Angeles and has a considerable hotel business supported by tourists traveling between those cities.

About a dozen of the small towns, villages, and hamlets of the Santa Lucia region, mostly one-street communities, serve principally as marketing points and business centers for restricted agricultural

communities. Two of these, Jolon and Lockwood, are in the midst of the Santa Lucia Mountains. All the others but one are located near the coast in the southern part of the region. Most of the inhabitants of the eastern margin of the region do their trading at various points in the Salinas Valley. Only one settlement, Santa Margarita, lying at the north side of Cuesta Pass on the state highway, is situated within this eastern margin. Other and quite different centers are the seaside resorts of which Carmel, Morro, and Pismo are chief.

There are only two ports worthy of the name in the Santa Lucia region, San Simeon and San Luis, both dating from the early days of the American occupation of California. San Simeon is but a shadow of its earlier self, and it is not unlikely that its trade will cease altogether in the near future. San Luis retains a measure of its earlier importance; it is now mainly an oil port, but some attempt is being made to add to its facilities and to develop it as a general port. The hamlet of Avila at the mouth of San Luis Obispo Creek is the center of business for this port.

LAND UTILIZATION MAPS OF MANCHURIA*

Nobuo Murakoshi and Glenn T. Trewartha

THE extent and area of Manchuria are somewhat uncertain as a consequence of the more or less elastic boundary which separates that province from Mongolia. In this study Manchuria will be understood to include the Three Eastern Provinces of China and the eastern part of Inner Mongolia (Table I).

TABLE I—AREA AND POPULATION, CULTIVATED AND ARABLE LAND OF MANCHURIA

DIVISION	SQUARE MILES	POPULATION	DENSITY PER SQUARE MILE	CULTIVATED LAND		ARABLE LAND	
				ACRES	PER CENT OF TOTAL	ACRES	PER CENT OF TOTAL
1. Mukden (Fengtien)	90,226	14,596,000	161.0	12,661,593	22.0	19,104,159	33.0
2. Kirin	81,019	7,596,000	93.7	8,559,915	16.5	15,345,698	29.6
3. Amur (Heilungkiang)	211,390	4,129,000	19.5	7,240,323	5.4	20,458,044	15.0
4. Eastern Inner Mongolia	60,551	4,366,000	72.1	3,903,374	10.0	8,127,561	21.0
Total	443,186	30,687,000	68.5	32,365,205	11.4	63,035,462	22.2

RELIEF, CLIMATE, SOILS

The heart of Manchuria thus defined is an alluvial plain whose flat surface has a total spread of more than 120,000 square miles. On the east, north, and west, highlands enclose the sediment-filled basin, these barriers drawing close together on the south so that the 300-mile breadth of plain in the latitude of Harbin is reduced to 75 miles where it fronts on the Gulf of Liaotung.

In its climate Manchuria bears most of the earmarks of middle-latitude continentality, viz. large seasonal extremes of temperature, short frost-free season, and meager precipitation remarkably concentrated in the warm season (see Table II).

South of Harbin most of the plain has 150 or more frostless days, this same isopleth extending much farther poleward in a narrow strip along the Sungari Valley (Fig. 3). In northwestern Manchuria the growing season is reduced to less than 100 days. South and east of

*The climatic maps and dot maps of crops are by Nobuo Murakoshi, agronomist of the Kungchuling Agricultural Experiment Station, South Manchuria; the isopleth maps of crops are by Glenn T. Trewartha, of the University of Wisconsin, John Guggenheim Fellow for Geographic Research in the Far East, 1926–1927. The data from which they have been compiled have been made available by the courtesy of the South Manchuria Railway, Dairen, Manchuria.

Harbin the precipitation is more than 20 inches, declining only very slightly to the north but more markedly to the west, so that the Ssu-Tao (Ssupingkai-Taonan) Railway serves a semiarid country whose rainfall is only 10–15 inches. Considering the meager amount of precipitation, the fact that 65 per cent in South Manchuria and 75 per cent in northern and western Manchuria fall in four months of the growing season is all the more significant.

The soils are alluvial and loessial in origin. The mineral content is high; but organic matter is deficient in parts of the plain, so that

TABLE II—CLIMATIC DATA FOR MANCHURIAN STATIONS

STATION	TEMPERATURE °F.		GROWING SEASON (DAYS)	RAINFALL (INCHES)	WARM-SEASON RAINFALL* (PER CENT)
	JULY	JANUARY			
Tsitsihar . (47° 28′ N.)	74.2	−2.7	147	10.2	73.2
Harbin . (45° 49′ N.)	75.4	−4.9	151	19.7	72.7
Changchun (43° 54′ N.)	74.0	0.9	141	26.2	73.7
Mukden . (41° 51′ N.)	76.5	7.9	132	26.5	67.3
Dairen . . (38° 54′ N.)	74.5	22.8	210	24.9	62.6

*The period from May to August inclusive.

the rich black colorings of chernozems are generally lacking. Structurally the Manchurian soils are not ideal; for, being composed of small particles and being cohesive, they are compact and inclined to turn a heavy clay after rains. In the western, sub-humid portions of the plain sands become more abundant. In spots poor drainage reduces the area of potentially cultivable land. Of greater extent, however, are the alkali lands, most abundant in the subhumid west, but also a deterrent to cropping in strips a few miles wide paralleling the rivers in other parts of the plain and along the coast. Extraction of soda from the soil is an ancient industry of Amur Province. It is estimated that ten per cent of the Manchurian plain is made unproductive by reason of alkalinity.

Fringing the margins of the plains and intermediate between the alluvium and the foothills are low terraces of older and somewhat higher alluvium. A belt of similar material extends in an east-west direction across the plain between Changchun and Mukden, forming a low divide between North and South Manchuria. Commonly the surfaces of these terraces, although not rugged, are somewhat more uneven than the plain proper. The soils, except for a shallow surface veneer, are brown or yellow in color. They are judged to be less valuable as agricultural lands partly because of their lower mineral content but more emphatically by reason of their greater aridity with the ground-water level deeper below the surface.

North and South Manchuria

In common parlance, and among geographers as well, a North Manchuria and a South Manchuria are designated. There is, however, no accepted line of demarcation between the two. In general, South Manchuria is that section served by the Japanese-owned South Manchuria Railway and having Mukden as its hub. In contrast, North Manchuria, with Harbin as its center, is served by the Chinese Eastern Railway—a line at least partly owned by Russia. Thus the south has come to mean the Japanese, and the north the Russian sphere in Manchuria. The southern plain in many respects is more similar to the northern part of China proper than is the region to the north and west of Harbin. This no doubt reflects closer proximity to Old China, the source of immigration, as well as the somewhat less severe climate in the lower latitudes. In the south the farms are relatively small and are composed of non-contiguous plots, the farmers living in villages rather than on their own farm land. North Manchuria is much more of a frontier country, where larger farms and somewhat more extensive methods of agriculture prevail. Here the tendency is for the farm to be a single block of contiguous land with the family residing on the farm.

To North Manchuria, however, the larger part of present immigration—estimated at over a million a year—is now directed. George B. Cressey[1] has estimated that one-third of the immigrants settle in Heilungkiang northwest of Harbin and north of Tsitsihar, one-third go to northwestern Mukden around Taonan and northward, and one-third to the rougher lands of eastern Kirin. C. Walter Young,[2] also estimating that two-thirds of Manchuria emigrants go to North Manchuria, gives a more detailed picture of distribution for the first half of 1927 with a map showing nine "settlement zones": Yalu River and Upper Sungari River in South Manchuria, Taonan, Upper Nonni River, Changchun Northern Zone, Western and Eastern zones of the Chinese Eastern Railway, Hulan River, Lower Sungari River in North Manchuria.

Agricultural Development

The most complete agricultural development of Manchuria has taken place in a belt from 100 to 150 miles wide stretching from the Gulf of Liaotung northeastward to Pehtwanlintze (Suihwa), the present terminus of the Hulan-Hailun Railway (Figs. 5 and 6). This area is superior to all sections of Manchuria in those elements of the natural environment making for agricultural prosperity. In addition, it is crossed throughout almost its entire length by an

[1] G. B. Cressey: The Geography of China, 3rd preliminary edit., Shanghai, 1928, p. 29.

[2] C. W. Young: Chinese Colonization in Manchuria, *Far Eastern Rev.*, Vol. 24, 1928, pp. 241–250 and 296–303.

excellent railway system. The influence of the means of communication—railroad, highway, and river—is clearly reflected in the series of dot distribution maps herewith. The relative regional importance of the various crops is brought out in the series of isopleth maps. Both series are based on data for the year 1927.

The most important cash crop of Manchuria is the soy bean, which occupied 24.5 per cent of the total cultivated land in 1927, ranking first in acreage. The crop is put to three primary uses: food for

TABLE III—AREA OF TILLED LAND AND PROPORTIONS UNDER EACH CROP BY AGRICULTURAL REGIONS

AGRICULTURAL REGION	AREA UNDER CULTIVATION (CHŌBU)*	PERCENTAGE UNDER EACH CROP						
		SOY BEAN	KAO-LIANG	ITALIAN MILLET	WHEAT	MAIZE	MILLET	OTHER CROPS
1. South of Mukden	1,860,000	17.5	36.4	12.7	.....	15.4	3.0	15
2. North of Mukden	1,811,800	26.0	30.2	18.3	.....	8.6	3.3	13.6
3. Ssu-Tao Line Region	619,000	16.6	24.9	23.1	.....	4.5	12.4	18.5
4. Mountainous Region	525,700	20.2	16.3	13.2	.....	27.2	.....	23.1†
5. Central Plain	2,397,400	30.4	20.7	19.0	9.2	5.3	3.8	11.6
6. Eastern North Manchuria	963,900	30.1	14.7	18.3	12.8	7.3	13.6	13.2
7. Western North Manchuria	3,222,400	34.7	13.5	16.6	14.5	4.4	6.4	9.9
8. Lower Sungari	1,131,000	35.7	12.2	11.3	19.2	4.9	.....	16.7
9. Rest of Heilungkiang Province	29,900	3.4	.....	9.9	45.0	8.7	.....	33§

*One *chōbu* equals approximately 2.5 acres.
†Includes paddy rice, 4.7 per cent.
§Includes barley, 9.7 per cent.

animals and man; oil, large quantities of which are sent overseas; and fertilizer, Japan and China proper purchasing bean cake in tremendous quantities. Until the spectacular rise of the bean—a matter of the last two decades only—*kaoliang* occupied half of all the cultivated land in Manchuria. This grain, the staple food of the native population and the principal grain food of farm animals, now occupies 19.2 per cent of the area.

Next to soy beans and *kaoliang*, Italian millet is the most extensively grown crop in Manchuria (16.4 per cent of the area). It is a staple food for the native population and is fed to live stock in large quantities as well. Wheat, occupying 10.9 per cent of the crop area in 1927, is the fourth-ranking crop. Maize comes next with a little over 9 per cent. The Chinese population values maize as a food, and the greater number of Chinese in the southeast may be a factor in explaining the relative importance of the crop in that section.

Both upland and paddy rice are relatively unimportant crops in Manchuria. The Chinese inhabitants are neither rice growers nor rice eaters: cultivation of the crop is chiefly in the hands of the Koreans, who consume it locally and sell to the Japanese in the cities.

FIG. 1

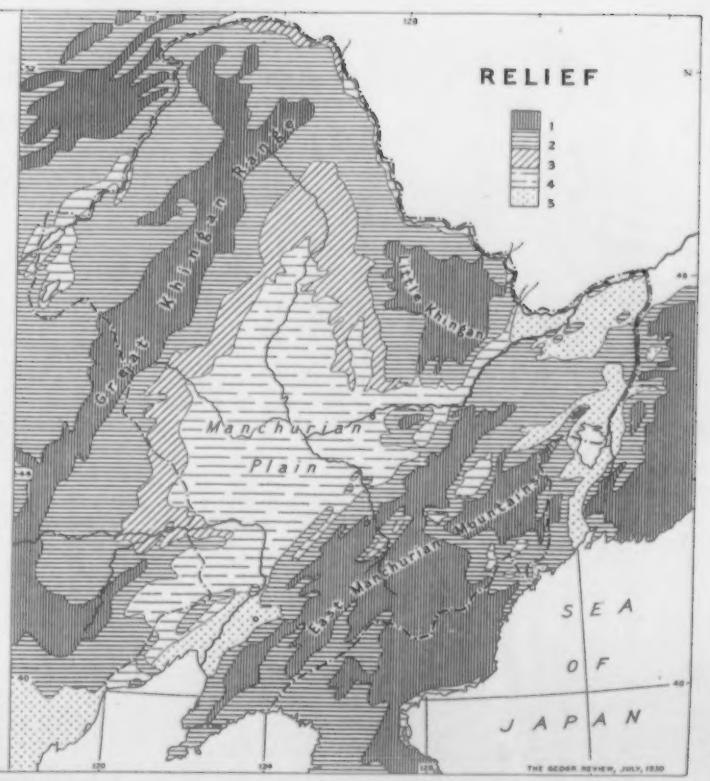

FIG. 2

FIG. 1—Map of Manchuria showing the provincial divisions and chief towns and railways. The important influence of the railways is clearly apparent in the crop distribution maps that follow. Scale of map approximately 1 : 16,000,000.

FIG. 2—Elements of relief. Numbers have reference: 1, mountains; 2, uplands and higher foothills; 3, lower foothills; 4, plains; 5, lowlands. Based on the orographical map, Pl. 11, in E. E. Ahnert's "Mineral Resources of North Manchuria" (reviewed in this number of the *Review*).

tribution maps that follow. Scale of map approximately 1 : 16,000,000.

FIG. 2—Elements of relief. Numbers have reference: 1, mountains; 2, uplands and higher foothills; 3, lower foothills; 4, plains; 5, lowlands. Based on the orographical map, Pl. II, in E. E. Ahnert's "Mineral Resources of North Manchuria" (reviewed in this number of the *Review*).

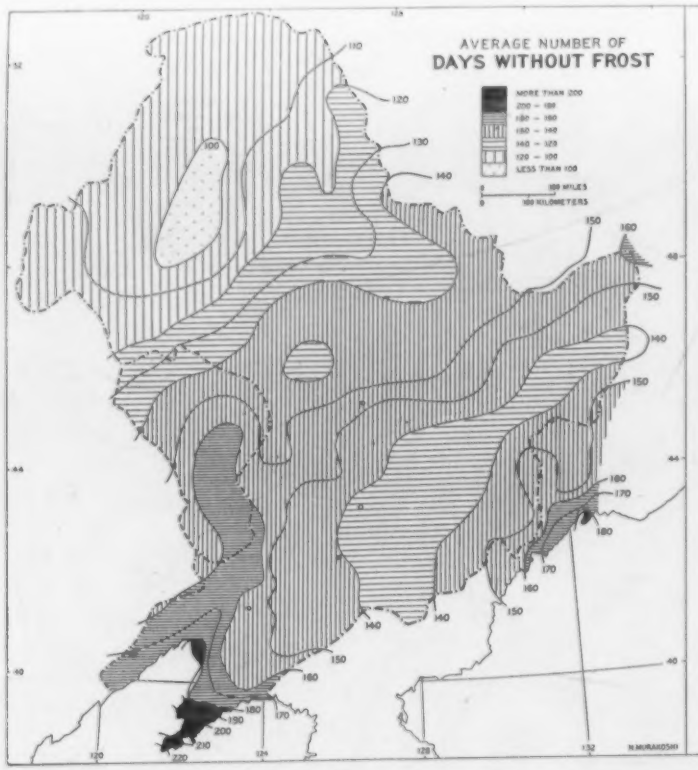

FIG. 3—Frost and the growing season.

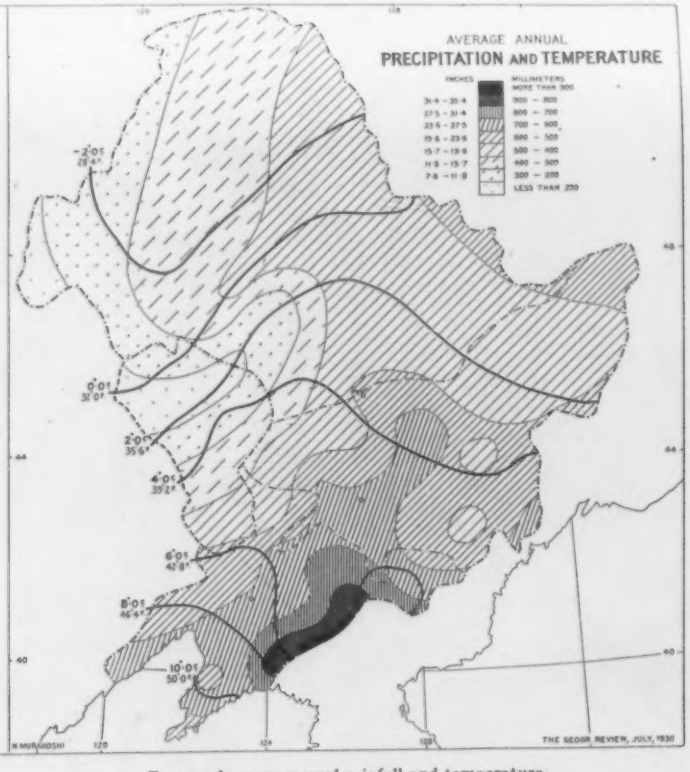

FIG. 4—Average annual rainfall and temperature.

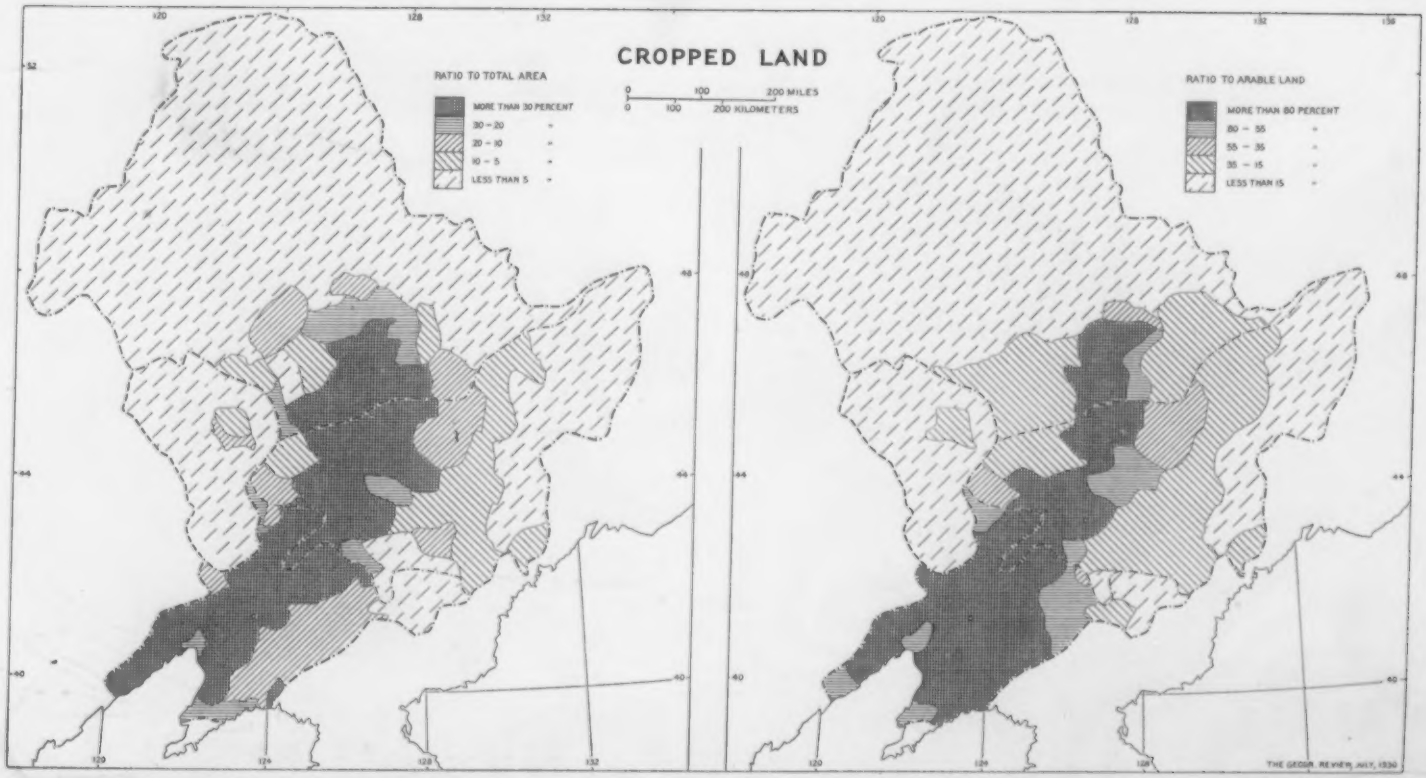

FIG. 5 FIG. 6

FIGS. 5 and 6—The percentage of the total land area of Manchuria under crops (Fig. 5) and the percentage of arable land in crops (Fig. 6). Compare with Figures 1, 2, 3, and 4. These maps make very evident the influence of the railroads in the settlement of Manchuria. The belt where 80 per cent and over of the arable land is under cultivation straddles the principal north-south line from Dairen to Pehtwantlintze. To the west of the line decreasing rainfall has discouraged rapid expansion. The arable sections of the rougher but more humid lands east of the line have been more completely utilized. (After map by Mr. J. Tochinai, formerly of the Agricultural Department of the South Manchuria Railway Company.)

of the South Manchuria Railway Company.)

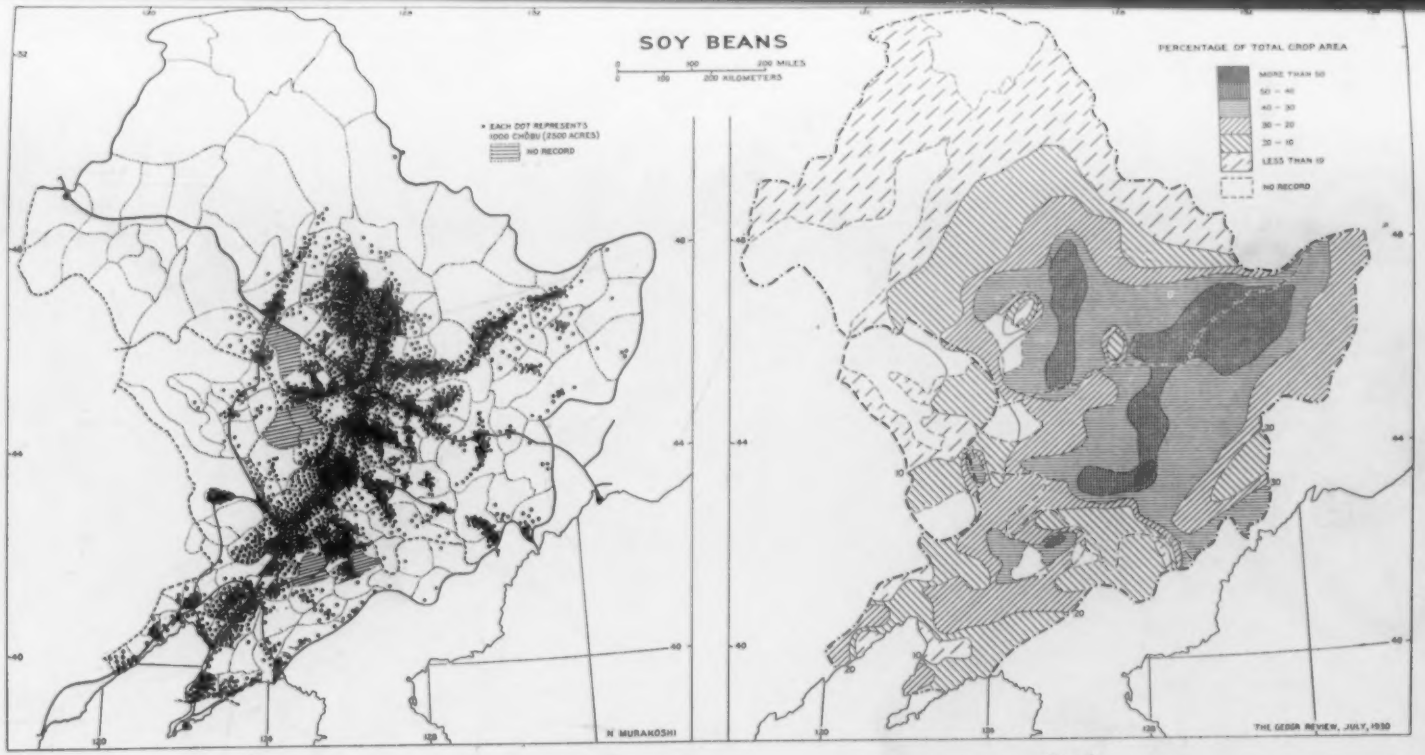

FIG. 7 FIG. 8

FIGS. 7 and 8—The soy bean crop reaches its greatest relative and absolute importance in the north, reflecting an ability to mature in a somewhat cooler climate with shorter frost-free season than is true of *kaoliang*. The beans grown in the north are reputed to be of higher quality, there being a progressive increase in their oil content with increasing latitude.

Note the linear distribution along the lower Sungari Valley: the patchy distribution in the rough lands of eastern Kirin; the influence of the Ssu-Tao Railway in the western sub-humid lands where, because of its long roots, the soy bean prospers.

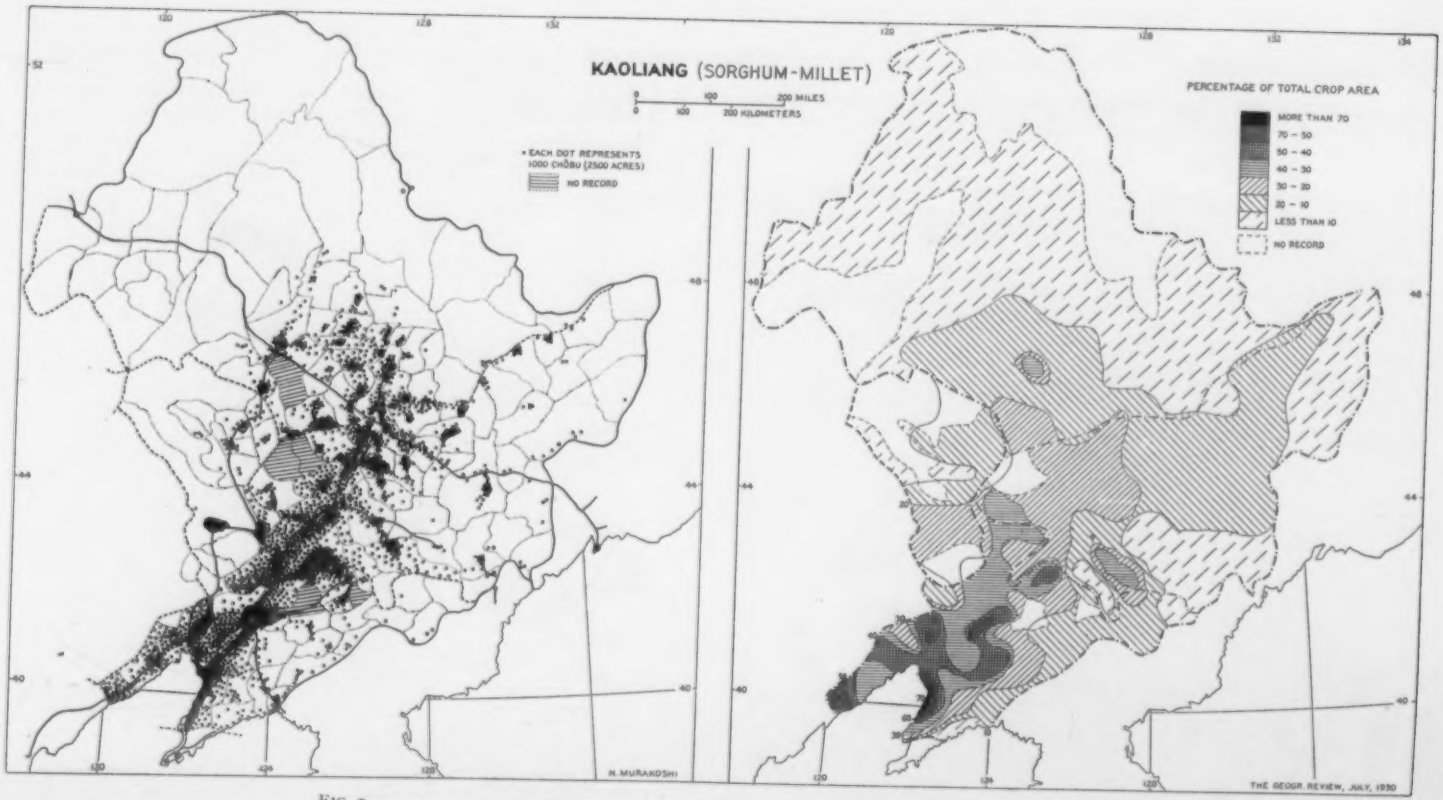

FIG. 9

FIG. 10

FIGS. 9 and 10—For its best growth *kaoliang* (sorghum millet) requires at least 150 days without killing frost; hence the crop reaches its greatest importance in South Manchuria. It is to the south what beans and wheat are to the north. Bordering the Gulf of Liaotung in the immediate hinterland of Newchwang it occupies over 70 per cent of the cropped land and around Mukden over 50 per cent.

The pattern of distribution (Fig. 9) reflects the prime influence of lines of transport with the chief concentration along the north-south railway. Clusters of dots around urban communities, where *kaoliang* becomes a commercial crop, give the map a patchy appearance.

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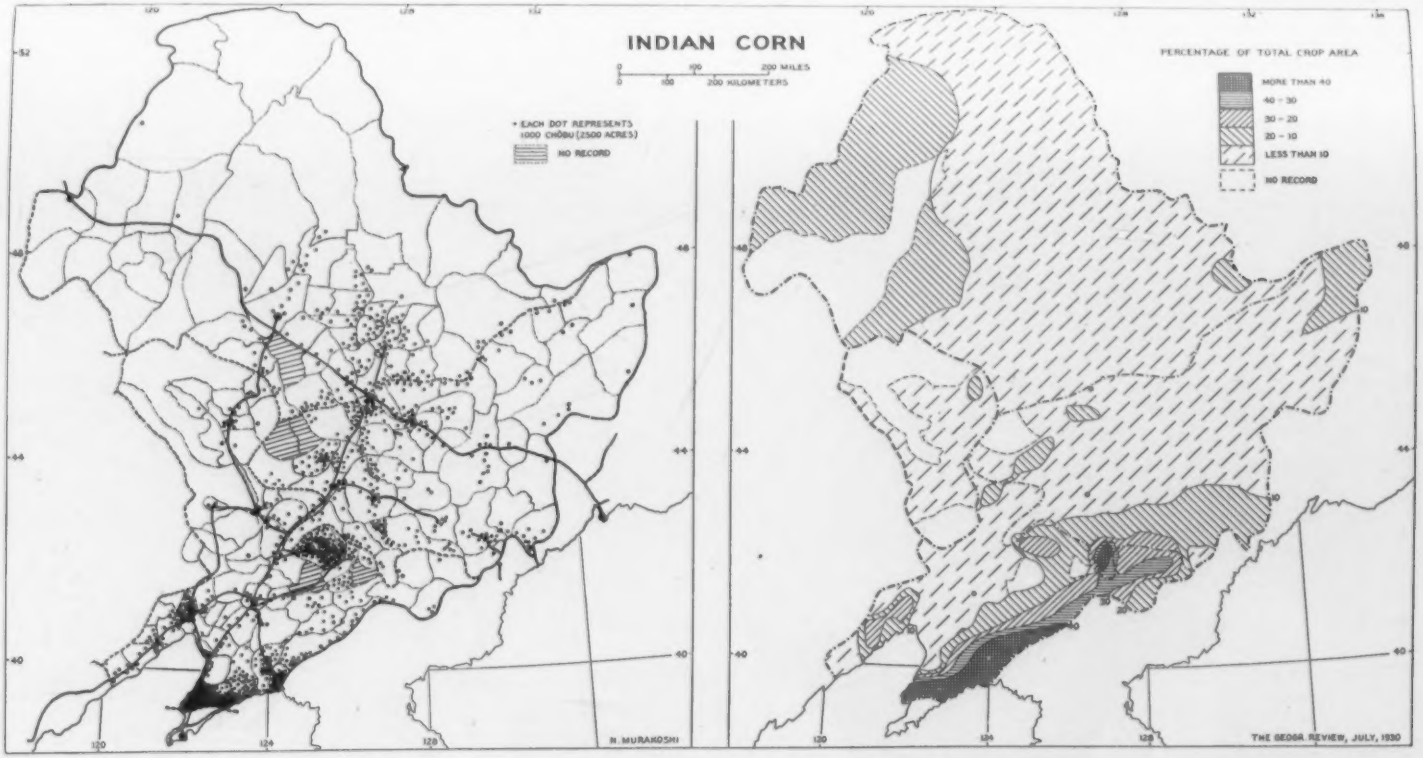

FIG. 11 FIG. 12

FIGS. 11 and 12—As it requires a relatively long growing season with at least a moderate amount of precipitation and a high relative humidity, Indian corn (maize) does not find optimum conditions over most of the Manchurian plain. It reaches its greatest importance—more than 40 per cent of the crop area—in the rough lands of southeastern Manchuria and in Liaotung, where the rainfall is 25–35 inches and the growing season more than 150 days. Indian corn, better than most grain crops, is adapted to hill-slope cultivation when tillage is of the simple hand-implement type.

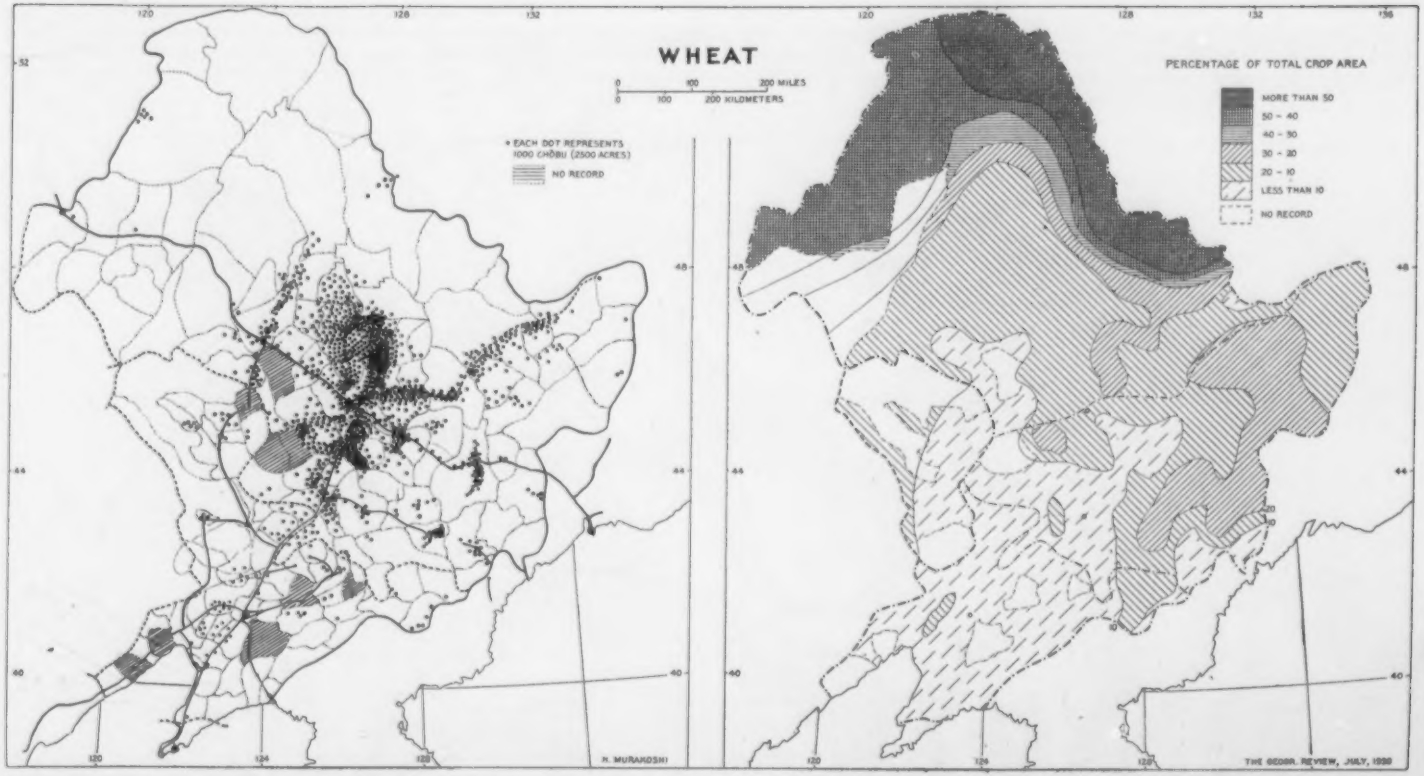

FIG. 13 FIG. 14

FIGS. 13 and 14—Wheat is emphatically a crop of the north, and on the far frontier where the total crop area is small it reaches its greatest relative importance. The competition of crops requiring a somewhat longer growing season is one reason for the lesser importance of wheat in the south. Eighty per cent of the crop is spring-sown. Rainfall throughout most of Manchuria is scant during spring and early summer, reaching a maximum in late summer and early autumn. However, late rains are less abundant in the north, and there also the moisture released by the melting of the snow cover in spring materially supplements the meager rainfall of that season.

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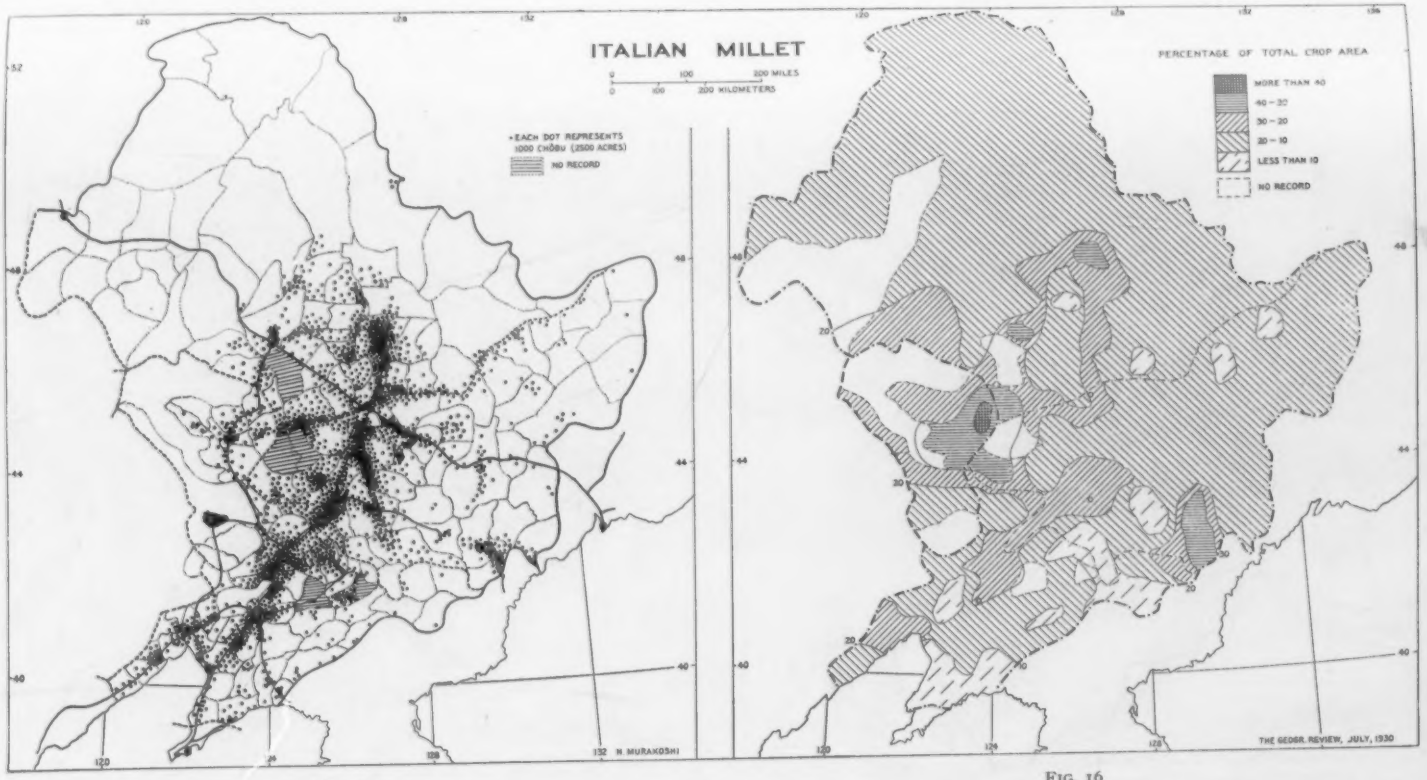

FIG. 15

FIG. 16

FIGS. 15 and 16—Italian millet is an important crop in both North and South Manchuria. Being deep-rooted and tolerant of drought conditions, its greatest relative importance is reached in the semiarid western lands: in one prefecture of Inner Mongolia, for instance, it occupies 40 per cent of the crop area. The linear and radial pattern of distribution repeats the influence of communications.

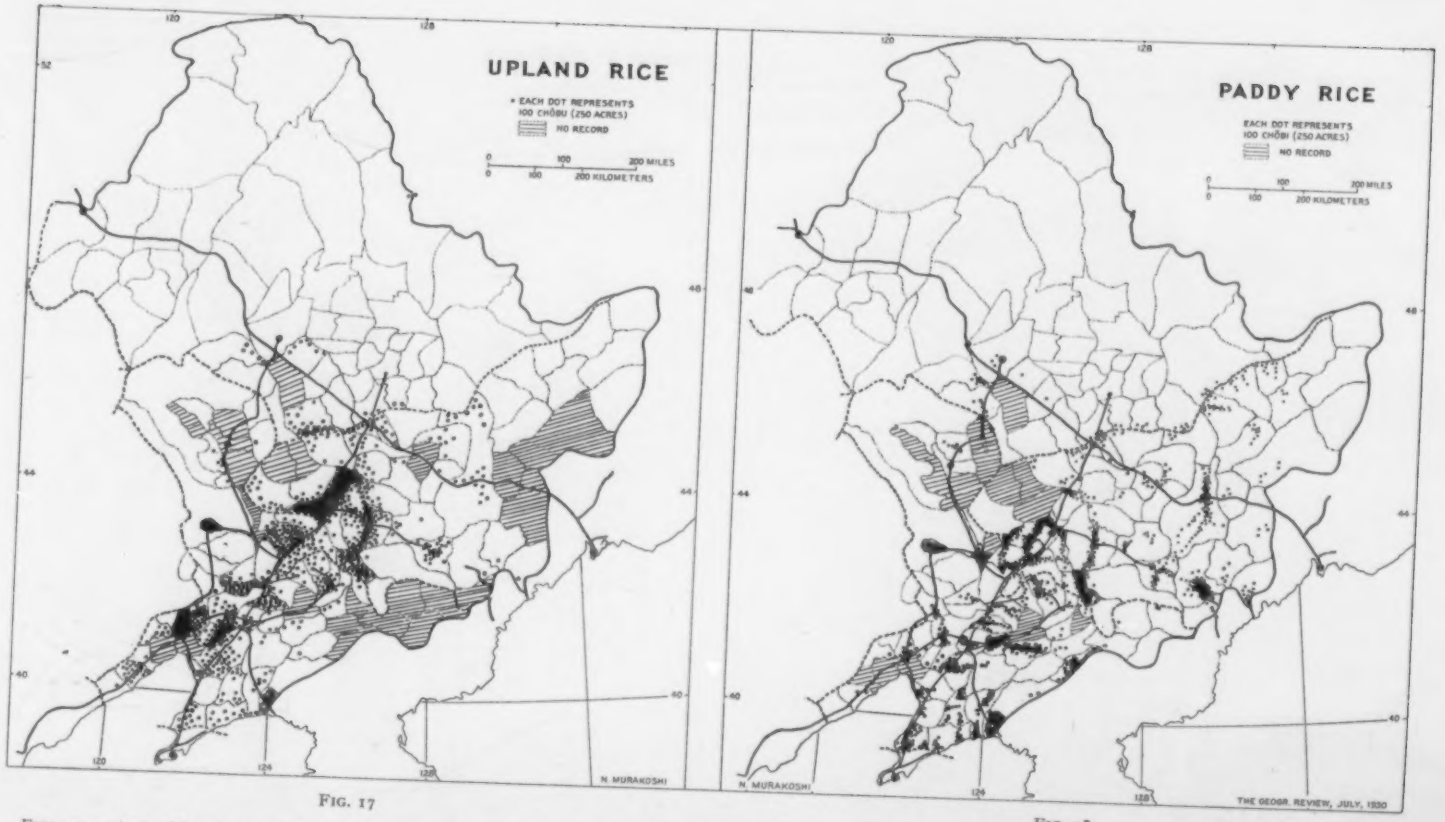

FIG. 17

FIG. 18

FIGS. 17 and 18—The principal center of cultivation of upland rice is in the vicinity of Changchun. The crop is not important. Paddy rice also is relatively unimportant, the period of high summer temperature being too short for its best growth. Short maturing varieties developed in Hokkaido are sown, but their yield is not more than three-fifths of what it is in subtropical Japan. Cultivation is limited to the neighborhood of streams where irrigation is possible. In comparing with the preceding maps note the change in scale, each dot representing 100 instead of 1000 *chōbu*.

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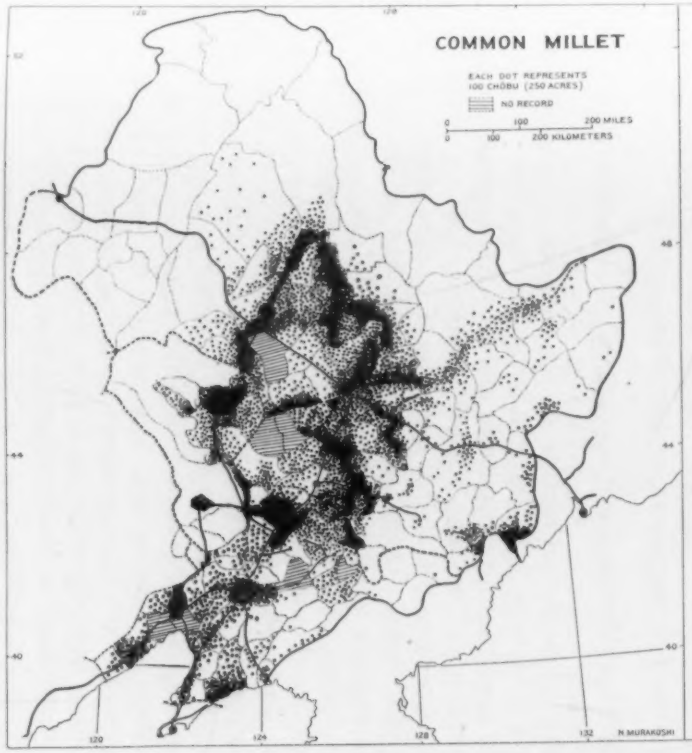


FIG. 19

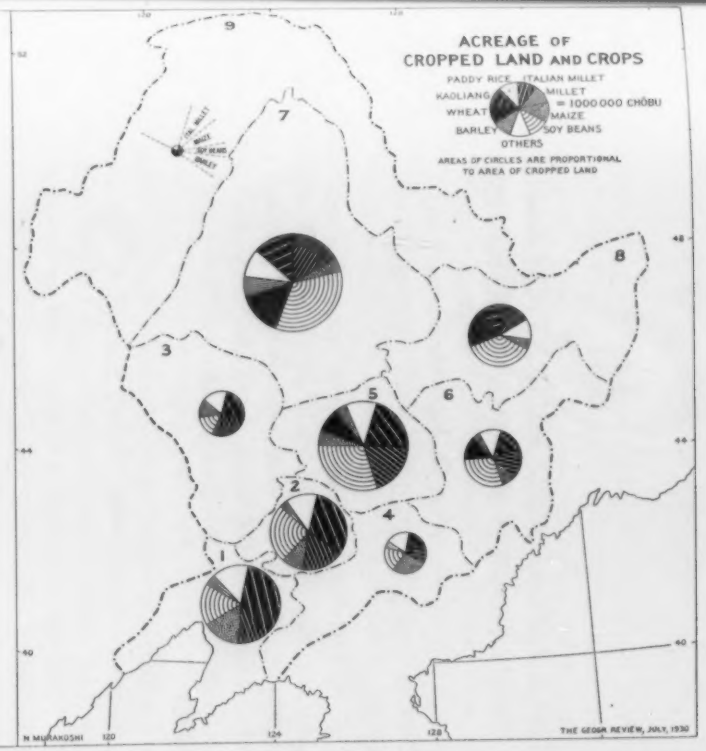


FIG. 20

FIG. 19—Common millet is widely distributed, for it is drought-resistant and tolerant of poor, thin, or alkaline soils, not sensitive to cold, and quick-maturing. Note zones of maximum production along the Ssu-Tao Railway on the somewhat poorer and droughtier soils bordering the western margin of the Manchurian plain and along the Nonni Valley and southeastward along the base of the Little Khingan Mountains with greater relief and soils inclined to alkalinity. Note that each dot equals 100 *chōbu*.

FIG. 20—Proportion of tilled land and major crops by agricultural provinces. These are: 1, South of Mukden; 2, North of Mukden; 3, Ssu-Tao Railway Region; 4, Mountainous Region; 5, Central Plain; 6, Eastern North Manchuria; 7, Western North Manchuria; 8, Lower Sungari; 9, Rest of Heilungkiang Province. See Table III.

TRIBAL AREAS AND MIGRATION LINES OF THE NORTH ARABIAN BEDOUINS

Carl R. Raswan

[With separate map, Pl. V, facing p. 502]

SINCE 1911 the writer has spent a total of about seven years among the Bedouins. The main purpose of his repeated visits to northern Arabia has been the breeding of Arab horses and study of their history. Incidentally he has been impelled to determine as accurately as possible the *dira* or pasture districts of the various Bedouin tribes.

The accompanying maps are based largely upon personal observations and inquiries among the 'Aneze, Shammar, Shararat, Huetat, Beni Sakhr, and other tribes, supplemented by data gleaned from Doughty's "Travels in Arabia Deserta" and more especially from Alois Musil's works. While the maps are in no sense final or complete, the writer is confident that their delineation of the tribal areas is more accurate than that shown on any previous maps.

Definite Boundaries

The migrations of the Bedouins are not arbitrary, aimless wanderings in the wilderness. Well defined landmarks limit them. Tribes related by blood ties may frequently use the same districts together at certain seasons of the year. One tribe may conclude a treaty with strangers, permitting the latter to use its pastures and watering places for a specified period. Or else a powerful tribe, like the Ruala, may invade an enemy's territory without warning. In this case constant bickering, raiding, and skirmishing is the inevitable result.

A great northward shift of the Shammar and 'Aneze nomads took place during the first part of the seventeenth century, and the existing apportionment of the tribal areas was at that time roughly established. The boundaries which the various tribes now claim as their own and which are marked by water holes, variations in the desert surface (as between lava rock, gravel, red sand, etc.), dry watercourses, solitary hills, mountain ranges, cultivated tracts, and the like, have been definitely fixed since the beginning of the last century. Some of the more important of these landmarks are shown on Plate V, facing p. 502.

As a typical example of a tribal area let us examine the *dira* of the 'Amarat tribe of the 'Aneze "nation" (Fig. 1). The eastern limit

of their wanderings approaches close to Baghdad, Kerbela, and An-Nejef. To the south, in seasons of sufficient rain, they pasture their herds on the tract of Al-Hejera; but when rain is scanty they move westward and thence northward around the southern and western edges of Al-Wudiyan. Thence, crossing Wadi al-Ghadaf, Wadi al-Hazimi, and Wadi Hauran (near Ar-Rutba, now a military outpost of 'Iraq) they reach their northern limits at the base of the mountains Abu Rijmen and Jebel Bishri between As-Sukhne and Deyr az-Zor. Within this *dira* lie the boundaries of the pasture districts of other tribes. In the north the Fed'an range as far south as 'Aqlat Shuab (where their great chief Turki ibn Mheyd lies buried), and the Sba'a go south to Wadi al-Ghadaf. The Fed'an and Sba'a are brother tribes, of the same blood as the 'Amarat, and all three unite when one is attacked by outsiders. The territory of the Ruala, also related by blood to the 'Amarat, overlaps that of the latter in Al-Wudiyan and Al-Hejera; and on the south Al-Hejera is also occupied by the Shammar (Fig. 2). In addition, the 'Amarat share part of their *dira* with 'Aqeydat, Dleym, and Khaza'el (Fig. 3), tribes of the second rank, despised by the strong Bedouins of noble blood, with whom, however, they are occasionally allowed to migrate.

Relation to Natural Features

Since very early times three great natural features have borne a close relation to the territorial subdivision of the major nomadic nations of northern and central Arabia. The first is a well defined depression that cuts across the entire peninsula from the Red Sea at Al-Wejh to Basra and is marked by the irregular lines of Wadi Humdh to the west and of Wadi Ruma' and its continuation, Al-Baten, to the east. The watershed between these two systems of wadies lies east of Khaybar in Jebel Abyadh. The ancient Bedouin tribes occupying areas north of this depression are now represented also in Syria and Mesopotamia, but those with pastures south of the depression appear to have remained in central Arabia.

The second great natural feature is the Nafud sand desert and its principal outliers, Al-Labbe and Ad-Dhana. The sands of the last reach south across Wadi Ruma' and, extending between Hufhuf and Riyadh, finally connect with the boundless southern sands of the "Empty Quarter." These *nafuds* have always constituted natural limits for the migrating nomads and their herds. During winter and spring they are healthful country: out of the sands, moistened by the rains, springs up a fragrant pasture growth, and the bushes sprout forth life-giving leaves and flowers; but at other seasons all is a desolate waste. On rare occasions the nomad nations whose normal ranges lie far north in Syria return to this cradle of their race. The northern

group of the Weld 'Ali, for instance, in certain winters wander with their powerful allies, the Ruala, southward to the neighborhood of Teyma', returning north again after their mares and camels have foaled.

The third great natural feature is the chain of hills (Ar-Rawaq, Abu Rijmen, and Jebel Bishri) which stretches in an almost straight line from Damascus to Deyr az-Zor on the Euphrates. Sheep-breeding Bedouins are found north of these hills, camel breeders to the south. The sheep breeders occupy a steppe-like rolling country, rich in pasture which lasts into the beginning of summer. Settled areas are nowhere far distant to east and west, and the tribes occupying these steppes will undoubtedly be the first to establish permanent settlements. As far north as Tel el-Abyadh near the Turkish frontier the writer has noticed members of the Fed'an intermarrying with settlers of that region. Mijhem ibn Mheyd, chief of the Fed'an, owns many villages in Syria, and several thousand of his Bedouins are even now at work in the fields, although the majority prefer tending live stock to plowing. The Tayy, one of the purest, most aristocratic Bedouin tribes from central Arabia, are now found in Mesopotamia, far north near Nisibin, where they seldom fold their tents, pack them on camels, and carry them to new pasture grounds. Half of their tents are "permanently" fixed, with reed and clay walls supporting the goat's-hair canvas. Indeed, the Tayy have become a degenerate people!

The Bedouins with the largest pasture circles (those bordering on the Nafud) will probably survive longest as true nomads. These are the great camel breeders, the Ruala and some of the Shammar, who hold the vast tracts of Al-Hamad and Al-Wudiyan between the Nafud and the northern line of hills.

Political Changes

If the problematical political frontiers between the British and French spheres of influence in northern Arabia are maintained, changes may be expected in the migration territories of the Bedouins. The following, in my opinion, might well take place. The tribes whose territories are now cut by the 30th parallel would split, part of them remaining in Ibn Sa'ud's domains and the rest migrating to the north. The continuance of yearly warfare (for the most part in the spring) between the Zana Muslim (Ruala and Weld 'Ali) and other 'Aneze tribes would finally result in an agreement that would assign to the Ruala who remain in Syria the entire Hamad and western part of Al-Wudiyan. The rest of Al-Wudiyan would be given to the 'Amarat, and the steppe country north of the hills to the Fed'an and Sba'a. First the Fed'an and then the Sba'a would gradually become

settlers, and the 'Amarat might ultimately be induced by the government of 'Iraq to settle in Mesopotamia after the new irrigation projects have been developed. The Ruala would undoubtedly hold out the longest against any such policy, many of them preferring to perish in skirmishes or return to their brothers in central Arabia rather than adopt the life of the settlers. The Weld 'Ali sheep breeders would settle in the neighborhood of Homs and Hama', and the camel breeders among them would remain with the Ruala.

Three hundred years have sufficed to bring the Bedouin tribes who left their central Arabian homeland to the brink of an abyss in which all the romance, beauty, and liberty of their nomadic life will disappear. Whatever one may think about the "backward, medieval, puritanical" rule of Ibn Sa'ud, the domain of this Wahhabi descendant of the Zana Muslim will some day be the last refuge for the few true Bedouin clans that love the old, free, glamorous, roving life better than the stale and degrading existence of the settlers in territories under French or British control.

NOTES ON THE MAPS[1]

Plate V shows tribal boundaries, natural features, and place names. Owing to the confusion resulting from the overlapping of the tribal areas, Figures 1, 2, and 3 have been added representing these territories as differentiated by shading. On these maps reference numbers are given to the following notes explaining certain points of interest in connection with the movements of each tribe. The place names mentioned in these notes will all be found on Plate V.[2]

Detailed tables revealing the internal subdivisions of the various tribes into subtribes, clans, etc., will be found in "A Handbook of Arabia," pp. 45–95, and also scattered through the various volumes of Alois Musil. In many instances these classifications do not correspond. Since the pages on which the tables are found in Musil's publications are not readily determined from the indexes, the following references are included for the benefit of those wishing to make a critical study of the organization of the tribes whose territories are shown on the accompanying maps:

Figure 1. 'Aneze Tribes. Zana Muslim, including the Ruala and Weld'Ali, A. D., pp. 14–16; Weld'Ali, A. D., p. 84. 'Amarat, A. D., p. 52. Fed'an, A. D., p. 55. Sba'a, P., pp. 55, 91. Weld Sleyman, N. N., p. 95.

[1] On the maps and in the text of this article Musil's renderings of the spelling of place names and tribal names have, in general, been followed. The transliteration, however, follows the English rather than the continental scheme, even in quotations from Musil's works.

[2] The abbreviations are as follows:

A. D., Alois Musil: Arabia Deserta, *Amer. Geogr. Soc. Oriental Explorations and Studies No. 2*, New York, 1927.

A. P., *idem:* Arabia Petraea, 3 vols., Kaiserliche Akad. der Wiss., Vienna, 1908.

M. E., *idem:* The Middle Euphrates, *Amer. Geogr. Soc. Oriental Explorations and Studies No. 3*, New York, 1927.

N. H., *idem:* The Northern Ḥeğaz, *ibid. No. 1*, New York, 1926.

N. N., *idem:* Northern Neğd, *ibid. No. 5*, New York, 1928.

P., *idem:* Palmyrena, *ibid. No. 4*, New York, 1928.

Handbook, "A Handbook of Arabia," Vol. 1, General, compiled by the Geographical Section of the Naval Intelligence Division, British Admiralty, London, 1920(?).

Doughty, C. M. Doughty: Travels in Arabia Deserta, 2 vols., London, 1888; 3rd edition, 1923.

Figure 2. Shammar and Related Tribes. Northern Shammar, Handbook, p. 78. Tuman, N. N., p. 32 (according to Handbook, p. 80, these are listed as a subtribe of the Aslam). Aslam, N. N., p. 33. 'Abde, N. N., pp. 32–33. Sinjara, N. N., pp. 31–32. Zefir, Handbook, pp. 81–83.

Other Major Tribes. 'Umur, P., p. 24. Beni 'Atiyye, N. H., p. 235. Beli, N. H., p. 211. Jeheyna, Handbook, p. 63. Harb, Handbook, pp. 64–67. 'Ateyban, Handbook, pp. 67–69. 'Ajman, Handbook, pp. 85–87. Muteyr, Handbook, pp. 83–84.

Figure 3. Tribes of the Second Rank. Jbur, M. E., p. 83. Hadediyyin, P., p. 151. Sha'ban: 'Afazle subdivision, M. E., p. 186; Welde subdivision, M. E., p. 188. 'Aqeydat, M. E., pp. 73–74. Dleym, M. E., pp. 143–144. Beni Tamim, M. E., p. 139. Zoba', M. E., p. 127. Khaza'el: Beni Selame division, M. E., p. 107. Fua're, P., p. 37. Sleyb: Al'Isa subdivision (the Sleyb are scattered over northern Arabia; some of their subdivisions and areas are indicated in A. D., p. 231). Kuakbe, A. D., p. 16. Beni Sakhr, A. P., Vol. 3, pp. 112–119. Shararat, A. D., p. 136. 'Imran, N. H., p. 79. Huetat ibn Jazi, N. H., pp. 6–7; A. P., Vol. 3, pp. 51–54. Huetat ibn Jad, N. H., p. 69; A. P., Vol. 3, pp. 54–55. Huetat at-Tihama, N. H., p. 129; A. P., Vol. 3, pp. 48–49. Humeyda, Handbook, p. 59; A. P., Vol. 3, p. 103. 'Amarin clan, A. P., Vol. 3, pp. 58–59.

FIGURE 1, 'ANEZE TRIBES

1. The inhabitants of Hama' and Homs entrust their flocks to the 'Ayde and Hsene groups of the Weld 'Ali. The sheykh At-Tayyar of the Weld 'Ali owns houses in Homs, Sheykh Hmed, and Al-Buer (see A. D., pp. 390–391).
2. North of Al-Barde are good lowland spring pastures of the Sba'a.
3. Near 'Aqlat Shuab is buried Turki eben Mheyd, Fed'an chief (A. D., p. 62).
4. Near Al-Baghdadi is a garden belonging to Ibn Hadhdhal of the 'Amarat tribe.
5. The lowland of Ar-Roza "is in cultivation and belongs to the head chief Fahad ibn Dreym ibn Hadhdhal of the 'Amarat tribe. His fortified farm, Al-Qseyr, is at the southeastern edge of the fields, and he maintains a small house at the spring of Al-'Esele" (A. D., p. 359).
6. The 'Amarat camp between Al-Felluje and Baghdad in August and September; later they go to Kerbela.
7. The family of Ibn Hadhdhal have houses at Kerbela and Rezaza (see A. D., p. 258).
8. Al-Hamad and Al-Wudiyan are the winter pasture grounds of the Ruala in years of sufficient rain; if the rains do not suffice they go to the eastern borders of the Nafud or to the vicinity of Teyma'.
9. "From the end of June until the end of August the Ruala pasture in An-Nuqra." This summer pasture is called *maqiz*. After September they leave for Al-Hamad and Al-Wudiyan (A. D., p. 408).
10. The people of Nasib pay tribute to Nuri ibn Sha'lan, head chief of the Ruala, when the Ruala return from Nejd in June (A. D., p. 353).
11. Libben is visited in lean years by the Ruala.
12. Some Muahib of the Qmusa subdivision of the Sba'a tribe camp with the Beni Sakhr; others with the Beli (see Figs. 2 and 3).
13. Route taken by the northern Weld 'Ali to their southern relatives on the Ruala *dira* (pasture districts).
14. The Huetat sometimes camp with the Ruala in this region.
15. In times of peace the Âl Dughman clan of the Ruala camp in this vicinity (see N. N., p. 12).
16. The well of Hebeke in the district of Al-Hazl or Al-Hzul once belonged to Ibn Bneyye of the Âl Sha'lan family of the Âl Mur'az clan of the Ruala (A. D., p. 15; N. N., p. 13).
17. Al-Ma'aniyye belongs to the 'Aneze, not to the Shammar (N. N., p. 32).

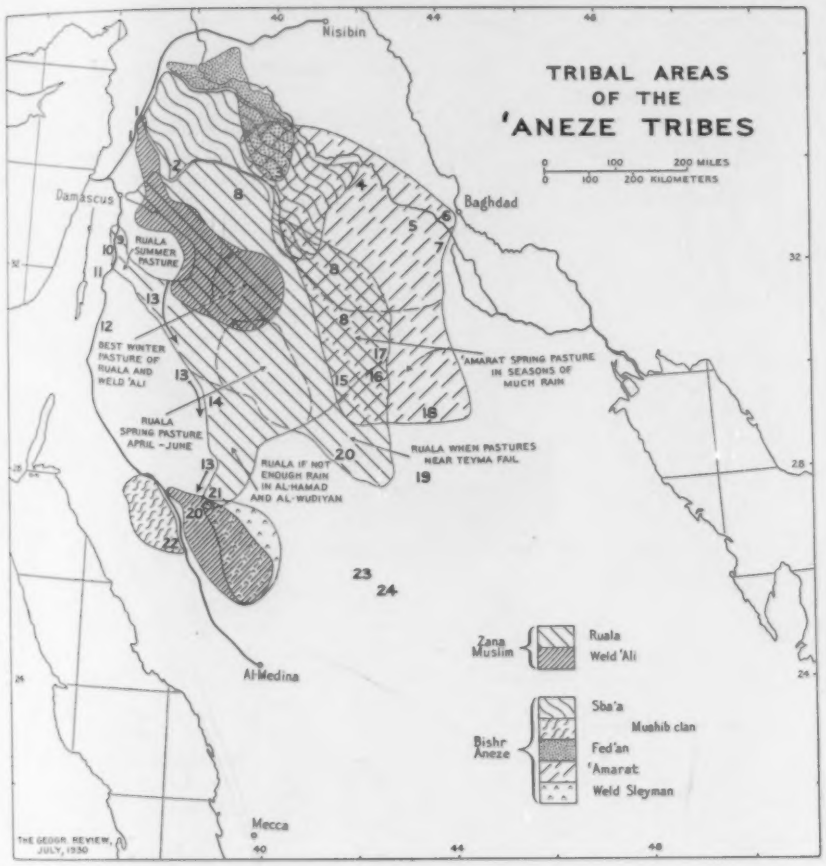


FIG. 1

18. The Hejera is the spring pasture grounds of the 'Amarat, Sinjara Shammar, Zefir, and even of the Muntifeq in seasons of plentiful rain.
19. Teysiyyet 'Aneze at one time belonged to the Dahamshe branch of the 'Amarat (A. D., p. 52; N. N., p. 26).
20. The southern Weld 'Ali and the Âl Mur'az clan of the Ruala join when the pastures southwest of Teyma' fail and go together into Al-Labbe and Al-Hamad (see A. D., p. 180).
21. When there is not enough rain in Al-Hamad and Al-Wudiyan the Ruala go to the vicinity of Teyma' and the northern Nafud. When they leave, their enemies (for example, Shararat, Weld Sleyman, Hteym, and Beni 'Atiyye) may take their place (A. D., p. 143).
22. "The best valleys upon both sides the Harra, next el-Hejr, are sown all years by some of the Moahib Aarab. Their harvest up, they strike the hamlets of tents, and with their cattle go forth to wander a while as the nomads" (Doughty, Vol. 1, p. 234).
23. Samira was formerly in the *dira* (territory) of the Ruala; the Harb and Beni Salem (Weld Sleyman) were taxed here by Ibn Rashid (Doughty, Vol. 2, p. 301).
24. Ibn Rashid taxed the Weld 'Ali at Al-Fuara (*ibid.*).

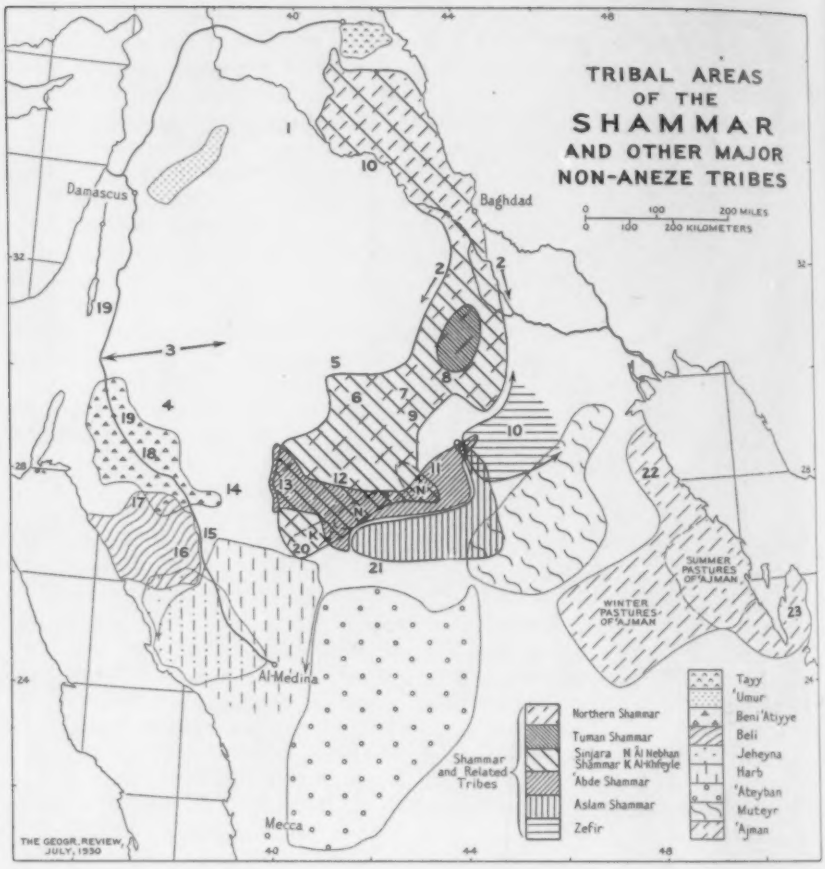


FIG. 2

FIGURE 2, SHAMMAR AND RELATED TRIBES

1. The Northern Shammar trade at Deyr az-Zor and have their agent (*wuqil*) there.
2. In certain years when the winter pastures are good the Northern Shammar migrate to Nejd.
3. The country between Ma'an and Wadi Sirhan after April is war territory between the Huetat and their enemies, the Shararat, Beni Sakhr, and Shammar (see N. H., p. 14).
4. Until the rain pools have dried up (end of April) the Huetat ibn-Jazi encamp near the mountains Al-Hamar and Al-'Afar in territory which belongs to the Shararat (N. H., p. 13).
5. Shammar are sometimes found in the vicinity of Al-Bueytat (see A. D., pp. 214–215).
6. Early summer camping grounds of the Sinjara Shammar.
7. Al-Hazl (Hzul): summer camping place of the Sinjara Shammar.
8. Cairn marking the grave of Bender, a chief of the Zmeyl clan of the Tuman tribe (N. N., p. 193).
9. See Fig. 1, note 18.

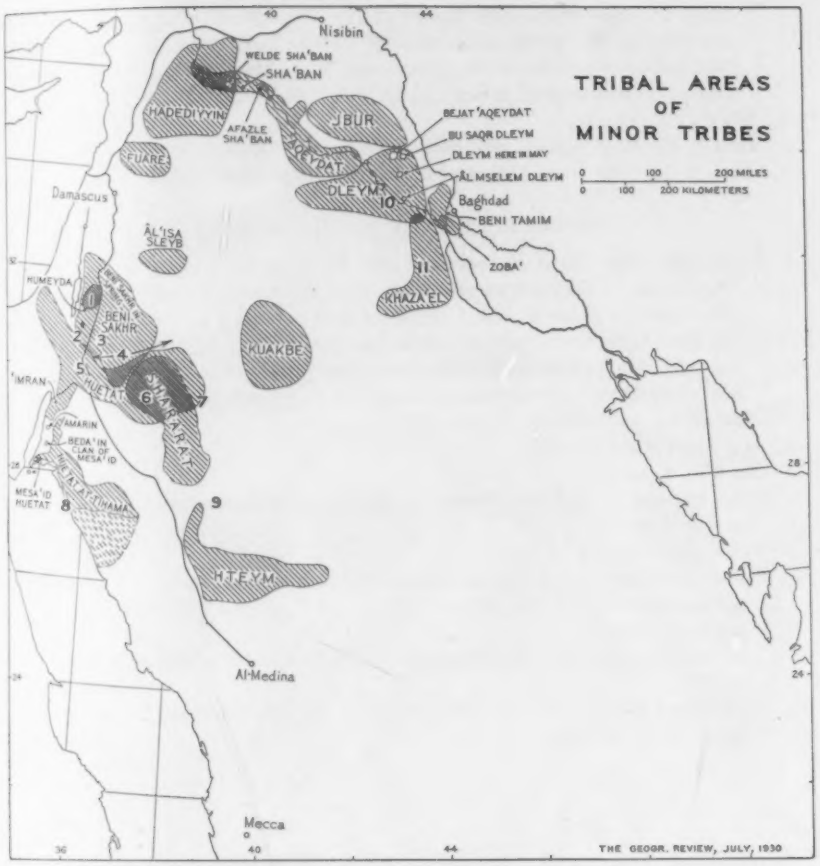


FIG. 3

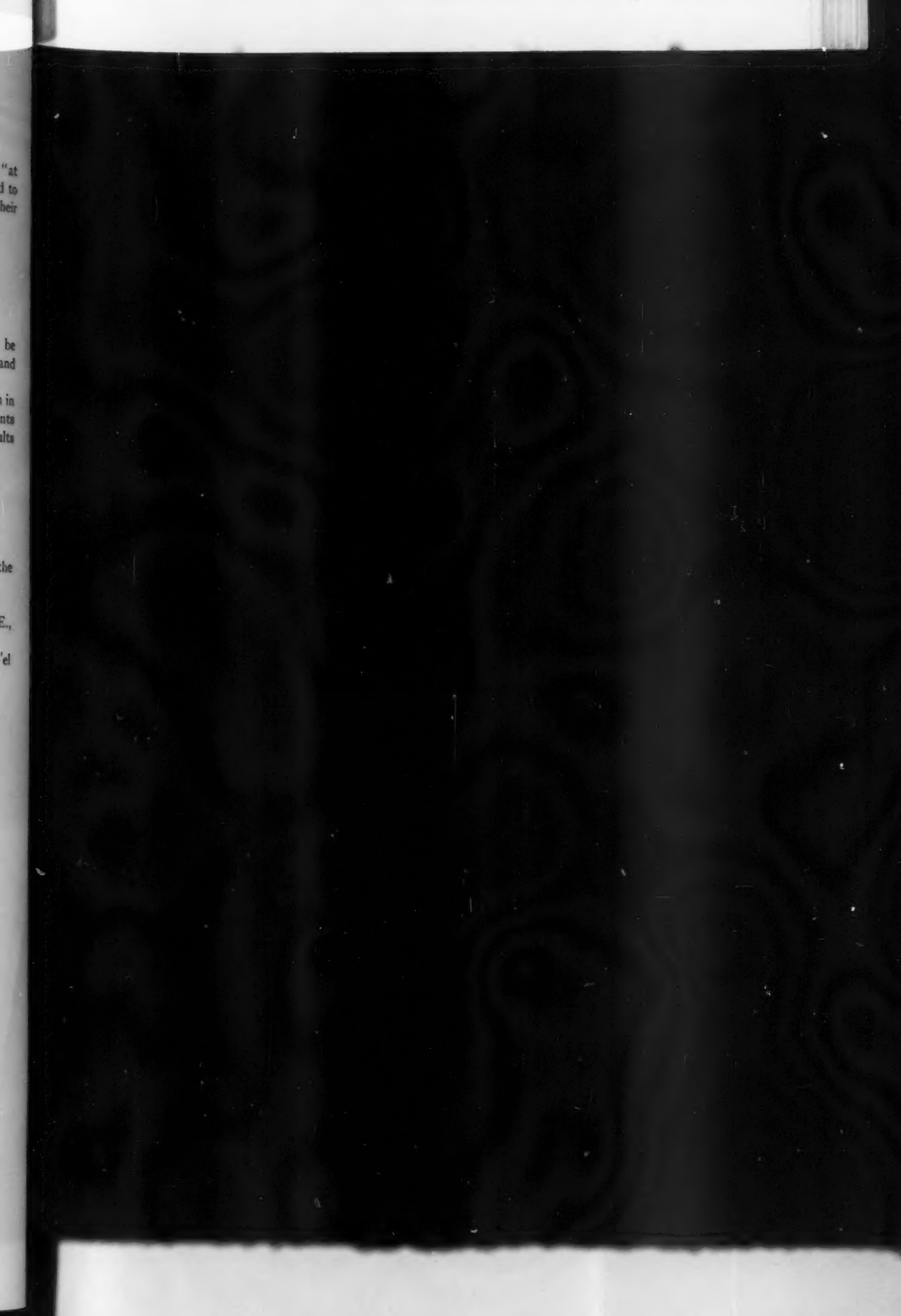
10. The principal center of the Zefir, kinsmen of the Shammar, is near the Persian Gulf, but they have been known to raid as far north as 'Ana.
11. Al-Khazra: "There are upwards of eighty wells at Al-Khazra, from eight to ten fathoms deep. They belong to clans of the 'Abde tribe [of the Shammar] who pitch their camps by them in the hot summer" (N. N., p. 27).
12. Umm al-Qulban: "The eight huts of this hamlet belonged to [the Shammar emir] Ibn Rashid, who, with Fahhad al-Qfe'i as supervisor, used to rear mares there" (N. N., p. 147).
13. The Shammar claim as their "home" the land east of Misma.
14. See Fig. 1, note 21.
15. See Fig. 1, note 22.
16. See Fig. 1, note 12.
17. Al-Jau forms the best winter encampment of the Beli and their enemies (N. H., p. 214).
18. The Beni 'Atiyye trade in Tebuk; and their head chief, Ibn 'Atiyye, has property there (see N. H., pp. 152, 161).
19. The Beni 'Atiyye send men in July to Kerak, Tafile, or Madaba to sell their camels there and buy barley (N. H., pp. 155–156).
20. The 'Amud clan of the Shammar "number about five hundred tents and usually

camp on the southwestern border of the 'Eja mountains." They were "at one time subject to the reigning family of Âl Jarba, who have emigrated to Mesopotamia together with their clans. The 'Amud have remained in their original homeland and joined the Sinjara" (N. N., p. 94).

21. See Fig. 1, note 23.
22. *Dira* of the Beni Khaled, also used during certain seasons by the 'Ajman.
23. *Dira* of the Beni Hajr, also used during certain seasons by the 'Ajman.

FIGURE 3, TRIBES OF THE SECOND RANK

1. Humeyda: The "Beni Hameydy," said by Doughty (Vol. 1, p. 26) to be "possessors of the most excellent strains of Arab horses, and in this fresh and plain country there is always plenty of wild pasture."
2. "The Beni Sakhr and the Huetat have no strictly defined frontiers, and when in the territory of the settlers both tribes often lay claim to the same settlements and exact payment from the same settlers. This proceeding generally results in skirmishes" (N. H., pp. 13–14).
3. See Fig. 1, note 12.
4. See Fig. 2, note 3.
5. After the end of April the Huetat ibn Jazi camp in this vicinity.
6. See Fig. 2, note 4.
7. See Fig. 1, note 14.
8. "The head chief Abu Tqeqa [of the Huetat at-Tihama] generally resided in the settlement of Zbe'" (N. H., p. 129).
9. See Fig. 1, note 21.
10. Two-thirds of the 5000 inhabitants of Hit come from the Dleym tribe (M. E., p. 27).
11. Al-Khzera: the property of Zaher, chief of the Moghara clan of the Khaza'el tribe (A. D., p. 369).



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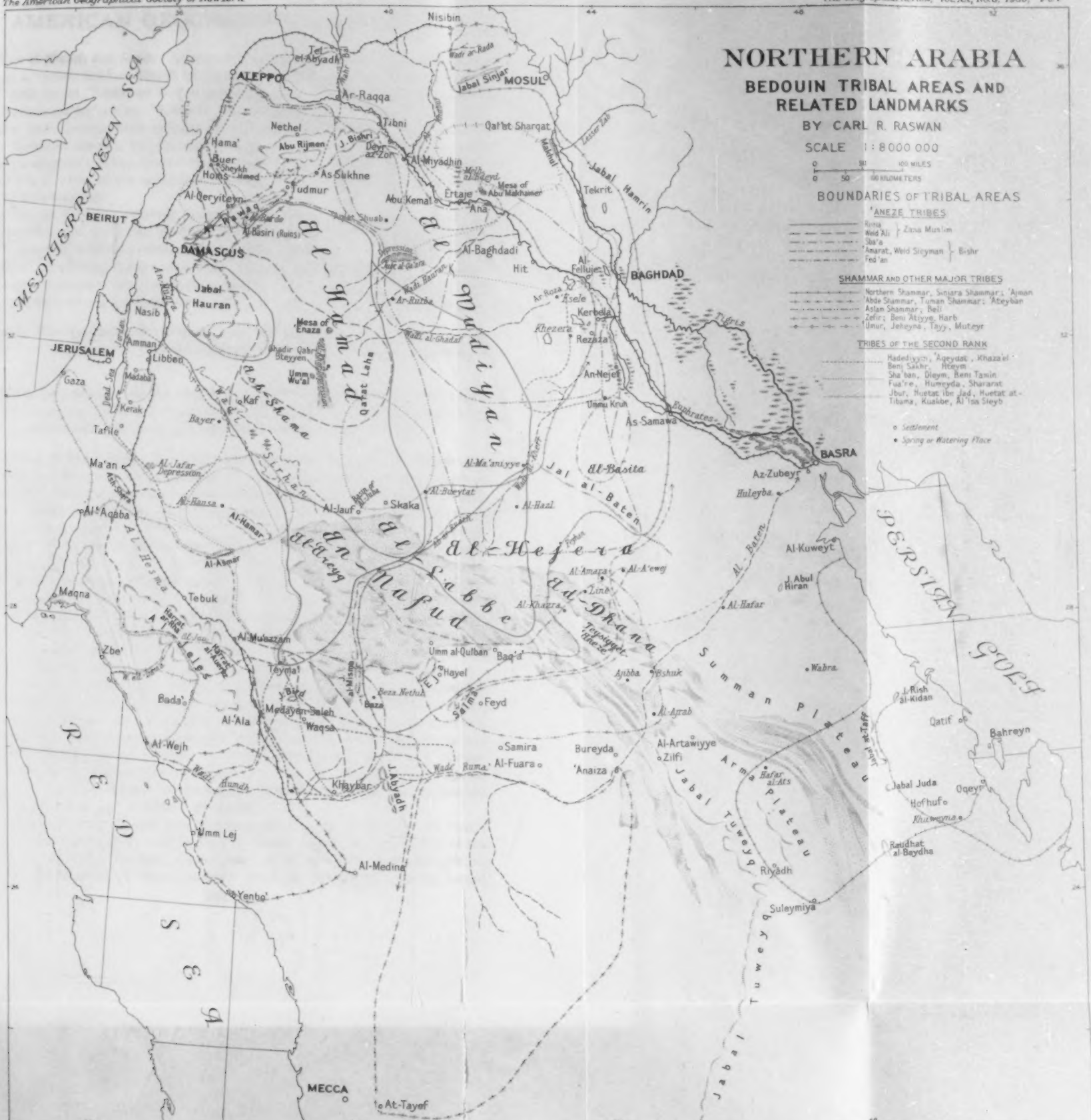

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AMERICAN GEOGRAPHICAL SOCIETY

Meetings of March and April. At the regular monthly meeting of the American Geographical Society held on March 25, 1930, at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding, Mrs. Thorstina Jackson Walters gave an illustrated lecture on "Iceland: The Kingdom of a Hundred Thousand," following a brief introductory address by Vilhjalmur Stefansson. Mrs. Walters, who is of Icelandic descent, has engaged in a special study of Iceland as well as the Icelandic communities in the United States and Canada. Special interest attached to the lecture in view of the millennial anniversary of the Althing that Iceland is celebrating this summer.

At the regular monthly meeting of the Society on April 22, 1930, held at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair, Captain Sir Hubert Wilkins addressed the Society. He spoke on "Further Antarctic Explorations," describing the season's work, 1929–1930, a complete report on which appears in this number of the *Geographical Review*. The address was illustrated with motion pictures, and comparisons were made with the work of the previous year.

Election to Membership in the Council. At the meeting of the Council of the Society held on March 20 Mr. Arthur Curtiss James was elected Councilor of the class of 1933.

Elections to Fellowship. At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of 35 candidates, who were duly elected as Fellows of the Society.

Presentation of the Charles P. Daly Gold Medal for 1929 to Cav. Filippo De Filippi. The presentation of the Charles P. Daly Gold Medal of the American Geographical Society for 1929 to Cavaliere Filippo De Filippi took place on May 1, 1930, at the American Embassy, Rome. In addition to members of the diplomatic corps there were present members of De Filippi's 1913–1914 expedition: Professor Giorgio Abetti, Professor of Astrophysics at the University of Florence and director of the Royal Observatory of Arcetri, who is shortly visiting America as Rockefeller Traveling Professor; Marchese Nello Venturi-Ginori, meteorologist of the 1913–1914 expedition; Colonel Cesare Antilli, in charge of the photography and assistant in topography; Count Camillo Alessandri of the Central Office of Meteorology in Rome, who was in charge of the research in meteorology, aerology, and radiology; and also Cav. Eng. J. A. Spranger. The ceremony was arranged by Ambassador John W. Garrett. In presenting the medal he spoke as follows:

"The American Geographical Society has awarded the Daly Gold Medal for 1929 to Cavaliere Filippo De Filippi and has done me the honor, through its Director and through the Department of State at Washington, of asking me to present it.

"Cavaliere De Filippi's most important expedition was in the Himalayas and in Chinese Turkestan in 1913–1914. He accompanied the Duke of the Abruzzi on his expedition to Karakorum in Kashmir, and to Mt. Ruwenzori in Uganda and, what is of special interest to Americans, was also with him on his journey to Mt. St. Elias in our own Territory of Alaska.

"The Charles P. Daly Medal was first awarded in 1902 to Commander Peary, discoverer of the North Pole; and in 1912 to Roald Amundsen, discoverer of the South Pole; to Captain Bartlett, Commander of Peary's ship, the *Roosevelt*; to Rockhill, former Minister to China, eminent sinologue who almost reached Lhasa;

and to Sir Francis Younghusband, who did reach that hitherto forbidden city. It is awarded by the Society for valuable or distinguished geographical services.

"Cavaliere—this is a happy opportunity of giving this important American honor to one who represents the best Italian traditions of energy and scientific achievement, as you, Sir, do."

Cavaliere De Filippi expressed the great honor that he felt on receiving this medal with which he wished to associate the names of his companions, some of whom were present, without whom his expeditions would not have been possible of accomplishment.

Award of the Charles P. Daly Gold Medal for 1930 to Lauge Koch. Announcement is made of the award of the Charles P. Daly Medal for 1930 to Lauge Koch of Copenhagen for his explorations in northern and eastern Greenland and his interpretations of the physical geography of that country. Dr. Koch's successful work as topographer and geologist on the Second Thule Expedition (1916–1918) led to his selection as leader of the Bicentenary Expedition of 1920–1923, on which occasion he made a memorable trip across northern Greenland from west to east and back. In 1926–1927 he undertook for his government a geological and economic survey of the central part of the east coast, returning in 1929 to carry out further investigations.

Award of the David Livingstone Centenary Medal for 1930 to José M. Sobral. Announcement is made of the award of the David Livingstone Centenary Medal for 1930 to José M. Sobral, Director-General of the Direcciòn de Minas, Geología, e Hidrología, Ministerio de Agricultura, Buenos Aires. Under Dr. Sobral's able administration his bureau has for many years been productively engaged in a program of mapping and geographical and geological studies, especially in the Andean section of the country. Of particular note is the method of survey adopted by Dr. Sobral—rapid reconnaissance based on a good triangulation, by which it is possible to cover large areas at a minimum cost with topographic maps that entirely satisfy present needs.

Recent Publications

The Work of the Byrd Antarctic Expedition, 1928–1930. Under this title a booklet of 71 pages has been distributed by the Society to 20,000 public schools and libraries in the United States. It constitutes a narrative unique among scientific documents in that it is derived from the radio despatches received day by day at the *New York Times* radio tower in New York from the expedition's station 11,000 miles away—an unsurpassed feat of communication. Each flight and sledge trip is briefly described, and some of the more important despatches are reproduced in facsimile as they appeared in the *New York Times*. The illustrations include a striking series of eight maps tracing the progressive advancement of knowledge of the Antarctic from 1760 to 1930. Two insert maps in color accompany the narrative. Plate I, on a scale of 1 : 6,000,000, is of the region from the Ross Sea to the South Pole and shows the routes of the various flights and sledge trips. The limit of the total area observed by the expedition, conservatively estimated at some 150,000 square miles, is defined and, in an inset, is laid down on a map of the United States. Elevations and soundings are given. Plate II, on a scale of 1 : 12,000,000, is of the region between New Zealand and the Antarctic and shows the routes of the *City of New York* and preliminary figures for the soundings made by sonic depth finder en route.

GEOGRAPHICAL RECORD

NORTH AMERICA

The North West Territories. "By the use of the aeroplane for transportation and investigation and wireless telegraph for communication, the boundary marking the generally accepted northern limit of resources of present-day interest was swept back a thousand miles into the north." Thus the "Preliminary Report on the Aerial Mineral Exploration of Northern Canada" (Department of the Interior, 1930), characterizes investigations made in 1928 and 1929 in the country west of Hudson Bay, chiefly in that portion of Keewatin District lying south of Chesterfield Inlet and in the vicinity of Baker Lake and covering an area of over 100,000 square miles. In conclusion the report states that the west coast of Hudson Bay "does not contain ore deposits of sufficient importance to be of present day interest." . . . "On the other hand the promise of discoveries made and formations found in Mackenzie District point to that as being the field of chief interest." But if the economic results are disappointing as regards Keewatin District the geographical information that has been gathered and here presented in outline is most gratifying.

This focusing of attention on the Canadian North—which comprises two-fifths of the Dominion—has led the Department of the Interior to issue a general compendium of available information on the larger of the two constituent territories, "The North West Territories, 1930." As illustrating the many interesting subjects in this valuable publication, reference may be made to the work for betterment of the essential needs of the native population—the conservation measures for the wild life of the country and the introduction of domesticated animals. The Thelon game sanctuary has been established specifically for the Barren-Ground caribou, "without protection it would be only a matter of time till the caribou suffered the same fate as the American bison." Preservation of the musk ox was also a factor in the selection of the Thelon area as a sanctuary. Conditions were investigated by Mr. W. H. B. Hoare in 1928 and 1929, a full report of which is to appear shortly. Mention of the introduction of Alaskan reindeer and the work of the Porsild brothers in that connection has already been made in the *Geographical Review* (Vol. 20, 1930, p. 153). Mr. A. E. Porsild's complete report, "Reindeer Grazing in Northwest Canada," is now available.

In 1926 the Porsild brothers started north by way of Alaska, where they observed the local reindeer, grazing areas, and methods of herding, which of recent years have been modified to conform with modern practices of stock raising (see L. J. Palmer: Improved Reindeer Handling, *U. S. Dept. of Agric. Circ. No. 82*, 1929). The following winter was spent along the northern shore of Alaska and Canada, and during 1927 and 1928 surveys were made of the Eskimo Lakes region and of the country to the north and east of Great Bear Lake with regard to their potential value as reindeer pastures. The Porsilds returned with perhaps the largest single botanical collection ever brought back from Arctic America, about 20,000 herbarium specimens. They concluded that the Arctic coast and Eskimo Lakes district would have a carrying capacity of at least 250,000 head and the Great Bear Lake basin of about 300,000 reindeer. While botanical reconnaissance was the primary aim of the Porsild Expedition, time was found for, among other things, a survey of McTavish Arm, a little-known arm of Great Bear Lake which presents physiographical features quite different from the remaining shore line.

Trading Areas in the United States. Except on rare occasions, as when an embargo is placed by state authorities on some farm product to prevent the spread of disease or blight, commodities freely cross the state and county boundaries of the United States. Internal free trade has permitted the structure of domestic commerce to develop without any necessary relation to the administrative geography of the country. But, "although the terms 'trading area' and 'trading population' are now well fixed in the vocabulary of distributers, sales plans and records in many instances still follow major political divisions. This principle has been dictated possibly by years of custom in collecting population and other statistics on a State basis," as Dr. Julius Klein has pointed out in his foreword to J. W. Millard's Atlas of Wholesale Grocery Territories (*Bur. of Foreign and Domestic Commerce, Domestic Commerce Ser. No. 7*, Washington, 1927, p. iii).

Several attempts have been made of late years to delimit the trading areas of the country on the basis of different criteria. In the atlas referred to, 183 wholesale grocery territories are marked off and statistics are given showing for each territory as a whole, for the counties which comprise it, and for its principal cities the population and the number of wholesale grocery outlets. Maps, colored according to the population of each territory, are included in the atlas. A general map of the United States showing the boundaries of the same areas accompanies Paul W. Stewart's "Market Data Handbook of United States" (*Bur. of Foreign and Domestic Commerce, Domestic Commerce Ser. No. 30*, Washington, 1929).

The commercial survey of New England recently undertaken by the Department of Commerce gives more details. Parts II and III of the published results (1929), by E. F. Gerish, entitled "Commercial Structure of New England" (*Bur. of Foreign and Domestic Commerce, Domestic Commerce Ser. No. 26*) and "Market Data Handbook of New England" (*ibid., No. 24*) present an abundance of precise information on distribution, food supply, recreational facilities, transportation, banking, and income (with a significant map showing per capita income by counties). Part I, "Industrial Structure of New England" by Dr. Artman, in charge of the survey, has appeared since this note was prepared.

The region is divided into 13 major marketing areas, groupings of counties having contiguous boundaries, "in which the principal trading center exercises the dominant influence," and also into 32 wholesale and 114 retail marketing areas determined on a township basis. They were "determined from interviews with approximately 2000 merchants, manufacturers, and others of commercial prominence in 168 towns and cities in the New England States." The 32 wholesale areas are "composites of local wholesale areas for such items as groceries, drugs, dry goods, hardware, mill supplies, tobacco, confectionery, and paper"; and the 114 retail areas represent the trading territories "of such outlets as department stores, women's specialty shops, men's clothing, furniture, and other retail stores." The boundaries of the various wholesale and retail areas respectively in the majority of instances are shown as overlapping; and, though it is recognized that their limits cannot be drawn with mathematical precision, they represent in some degree the actual functioning parts of the mechanism of New England's internal commerce.

The areas would seem to bear little direct relation to physiographic or other natural regions. For example, one looks in vain for traces of "adjustment" of the wholesale trade areas of central and northern Vermont to the line of the Green Mountains. The Rutland and Burlington wholesale areas include nearly as much territory to the east as to the west of the range. This is striking, because the mountains have long been an important dividing element in the political life of the state. Farther south, the borders between the wholesale areas centering at Rutland, North Adams, and Pittsfield on the west and at Keene and Springfield on the east correspond roughly to the Green Mountain-Berkshire ridge, and there is a somewhat similar relation between topography and the retail areas of this region. The Connecticut

River for a considerable stretch marks the western edge of the wholesale areas of Concord and Manchester, but on the whole the river is a unifying rather than a dividing factor. The wholesale and retail areas alike of the Connecticut Valley towns tend to include territory on both sides of the stream. What immediately controls the areal pattern of New England's commerce is not topography but the distribution and density of population, the layout of the transportation routes, freight rates, and, in some degree, trading traditions inherited from the past.

Rural Depopulation in Virginia. The results of a survey recently published by the Institute for Research in the Social Sciences at the University of Virginia gives a cross section through two related problems that are arousing widespread discussion at the present time: rural depopulation and the migration of negroes from the South to the North (Wilson Gee and J. J. Corson, 3rd: Rural Depopulation in Certain Tidewater and Piedmont Areas of Virginia, *Univ. of Virginia Institute Monograph No. 3*, 1929). The area dealt with comprises three piedmont counties and seven tidewater counties. Distinctively rural, with no villages of over 500, the population of these counties has not only materially declined since the Civil War but is even less than in 1790. The percentage of decrease from 1790 to 1920 ranged from 2.1 in the piedmont county of Goochland to 27.2 in the tidewater county of New Kent. In most of the counties there are more negroes than whites. Negro and white population alike have declined; the percentage of negroes, except in Charles City County, was less in 1920 than in 1790.

In the survey detailed records were secured for 1910 whites and 1466 colored persons, both migrants from the area and non-migrants. "Of the white migrants 60.2 per cent did not leave the borders of the State. A fairly large percentage remained in the rural districts, and both those who remained in the State and those who left the Old Dominion are found scattered over a large expanse of territory. . . . On the other hand, the Negroes concentrated in a comparatively small number of cities [notably New York, Philadelphia, Baltimore, and Washington]. They more often settled in the urban centers than did the whites, and only 27.2 per cent of those who left the area remained in Virginia." Relatively few (12 per cent) of all the male migrants went into farming, although the majority came of farm families. A large number of occupations—mostly of the unskilled or semi-skilled type—is represented among the migrants, and "naturally a much larger percentage of the Negroes is found in the laboring classes than of the whites."

The survey would seem to show that there is more migration from owner-operated farms than from tenant farms and that migration takes from the region not only "those in the most productive years of their lives" but those who have received better education. While the lot of the migrant may be improved, migration by skimming off the cream of the population is creating an increasingly difficult situation for those who remain at home. The burden of maintaining roads, schools, and county government is falling on a diminishing number of the very individuals least fitted to support it. "Except in Charles City, New Kent and Rappahannock counties, there is relatively little wealth per capita for taxation for county purposes. . . . This condition is largely attributable to the unprofitableness of agriculture. The capacity of the soils in this area to support a successful agriculture is attested by the United States Bureau of Chemistry and Soils on the basis of a special reconnaissance study. That a successful system of agriculture is not existent here is shown by the crop values and the farm income figures. A considerable part of the blame for this condition must be borne by the people of the area."

The authors do not propose definite remedies. They suggest, however, as possible measures of relief "better schools, improved roads, a further extension of farm and home demonstration work, health units, attraction of manufacturing adapted to the area, and a number of similar movements."

EUROPE

Administrative Divisions of Jugoslavia. In an article appearing in the *Geographical Review* of January, 1925, Professor Milojević of the University of Belgrade discussed from a geographic viewpoint the administrative divisions of the Kingdom of the Serbs, Croats, and Slovenes as promulgated in 1922. He summarizes his study by saying, "We must admit that religion and party politics have still proved the decisive factors in the new subdivisions of the country." A step forward in the direction of establishing a natural and economic subdivision was taken in the Royal

FIG. 1—The new administrative divisions of Jugoslavia. The capitals and area and population (1921, figures from *Almanach de Gotha*) of the *banovines* are shown. Belgrade and the adjacent towns of Zemun and Pančevo constitute a separate unit with a population of 150,000. Compare with the former divisions as shown in *Geographical Review*, Vol. 15, 1925, p. 71. Scale 1:7,800,000.

Decree of October 3, 1929, by which the Kingdom of the Serbs, Croats, and Slovenes becomes the Kingdom of Jugoslavia, and the thirty-three administrative divisions are supplanted by nine provinces or "banovines." In one instance geographic unity is achieved by doing away with the narrow littoral provinces and uniting them with their natural hinterlands into three large banovines. Hitherto the important rivers were almost universally employed as boundaries; they are now treated as economic corridors, and the boundaries of the new provinces are drawn so as to include the tributary area with each stream. In discussing the new scheme (La réorganisation administrative du royaume de Yougoslavie, *Le Monde Slave*, Vol. 4 (N. S.), 1929, pp. 321–341) M. Yves Chataigneau points out that the mountainous province of Drava includes most of the Slovenes, and Ljubljana, the capital, is the principal Slovene city. Sava owes its unity to its relief and the resulting communications

pattern; and the same thing is true of the Littoral division and Zeta, which represent respectively the economic spheres of Split and Cetinje and their connections with the interior. Drina, with its center Sarajevo (cf. Yves Chataigneau: Le bassin de Sarajevo, *Ann. de Géogr.*, Vol. 37, 1928, pp. 306–327), includes parts of several old kingdoms and represents a new economic district, the region south of the Sava River. Vrbas corresponds almost exactly to the natural region of "Bosnian *Krajina*." The Danube province is the economic region of Belgrade, although the city is treated as a separate political unit. The Morava-Vardar geographic region of Professor Milojević's paper is now divided into two provinces bearing the names Morava and Vardar.

Is the Summit of Mont Blanc in France? The map of Mont Blanc made by the French captain Mieulet in 1875 and the official French topographical map, 1:80,000, both show the supreme summit (4807 m.) as lying wholly in France, the Franco-Italian frontier passing over a lower spur, Mont Blanc de Courmayeur (4748 m.), about 700 meters to the southeast. This claim is reasserted by Henry Bregeault in a recent coöperative book, "La Chaîne du Mont Blanc." Giotto Dainelli, however, points out that the Convention relating to the establishment of the boundary between the Kingdom of Sardinia and France (May 7, 1861) stipulated that "Du côté de la Savoie, la nouvelle frontière suivra la limite actuelle entre le Duché de Savoie et le Piémont." Earlier official maps, together with the map which accompanied the Convention, show the frontier as following the watershed and thus traversing the main summit. Since there has been no subsequent modification of the terms of the Convention in this regard, the French claim to the exclusive possession of Mont Blanc's highest point would seem to be unsubstantiated. (Giotto Dainelli: "Il Monte Bianco ed il confine italo-francese," *Boll. Reale Soc. Geogr. Italiana*, Ser. 6, Vol. 6, 1929, pp. 451–456.)

Studies of Catalonia. The development of tourism has given encouragement to the publication of regional studies in Catalonia. Marcel Chevalier originally prepared his "Les Paysages Catalans" (1929) as a volume in the Enciclopedia Catalunya. The French text differs a little from the original Catalan, and a large number of photographs have been added. Chevalier, an authority on Andorra, is an ardent student of Catalonia. His book is a historical and descriptive physiography. He commences with an analysis of landscapes, speaking of them in terms of form and color. The form consists of the *profondes*, the geologic aspects, and the *superficielles*, the physiographic. The color is affected by the soil, climate, and vegetation. Human culture is treated separately. This analysis is interesting at a time when Granö has given us the almost too detailed study of landscapes in his "Reine Geographie" (see *Geogr. Rev.*, Vol. 20, 1930, pp. 171–172). With no further introduction the writer begins analyses of the regional landscapes of Catalonia. Some interesting studies are made of alluvial changes along the coast since Greek times.

Within the area of Catalonia is a small, fertile plain, faced on three sides by mountains. This is the plain of Vich, north of Barcelona. The town of Vich is a farming center and has educational and ecclesiastical importance. Gonçal de Reparaz (Fill.) has given us "La Plana de Vic" (Barcelona, 1928). J. R. Bataller has collaborated to the extent of writing the introductory geological chapters. One interesting aspect of this book is the insight which it gives us into Catalan scientific activities. The Catalans, with a press of their own (not to speak of their university at Barcelona), are as active as any of the Spanish groups. This single volume, numbered 8 and 9, is a part of the "Enciclopedia Catalunya," a publication with a wide scope if one may judge from its editorial board. P. Vila, a distinguished geographer, is of the staff. The book begins with the bibliography. After that the treatment is conventional enough. The region being small, the study is much detailed. Thus

in Chapter 5, which is on occupation of the soil and house types, the study goes back to primitive sepulchers of the aborigines. Chapter 7, on social geography, is worthy of note. The divisions of social geography as there presented are demography, criminology, social organization of industry, pathological and hygienic geography, character of the people of the plain, and the town of Vich as an ecclesiastical center. It was a surprise to the reviewer to note that precipitation had a spring maximum and that, as shown on page 320, there was an unexpectedly great annual variability. Strangely enough the meteorological year begins on December 1. The book is unusually well illustrated, and the photographs show well the individuality of Catalan culture.

Another aspect of precipitation in Catalonia is treated by Ramón Jardí in "Estudis de la intensitat de la pluja a Barcelona" (*Memòries Inst. d'Estudis Catalans, Secció de Ciències*, Vol. 1, fasc. 2, Barcelona, 1927). This study is based upon thermographic records showing millimeters of rainfall per minute. The rains illustrated are torrential deluges of short duration. Besides being of local climatic importance, the study is a contribution to meteorology.

Not the least distinctive feature of the Catalan region is its industrial activity in contrast to the essentially agricultural character of the rest of Spain. This phase of Catalan life is dominated by the influence of Barcelona, a city always favorably situated for outside contacts, as P. Vilar describes in an interesting article, "La vie industrielle dans la région de Barcelone" in the July, 1929, number of the *Annales de Géographie*.

RODERICK PEATTIE

Land Utilization Map of an English County. A unique experiment in regional survey has produced the "Land Utilization Map of the County of Northampton," published by the Northamptonshire Education Committee. Mr. E. E. Field, controller of the survey, describes the map in *Geography* for March, 1930 (pp. 408–412). The data were collected by school children under the supervision of their teachers, practically every school of the county contributing. The survey was done on a parish basis, with the use of the six-inch Ordnance map. The base was first checked as regards parish and field boundaries, roads, etc.; then utilization was mapped by an agreed set of symbols under date of August, 1928. The units were assembled by the controller. "The complete map is in three sheets on the one-inch scale. Arable land, pasture and woodland are shown in three colours, and waste land, including mineral workings and areas covered by buildings, is uncoloured. The printing has been done by the Ordnance Survey Office, Southampton. The surface utilization information has been shown upon the ordinary grey background of the one-inch map, with water in blue."

Obviously the work has educational value of a high order, not least in the fact that it is intrinsically useful. Relationships brought out on the map suggest further studies, and in a broad sense it is hoped that the pursuit of such studies may foster a renewal of interest in the countryside.

The success of this pioneer piece of work has led the Geographical Association's Regional Survey Committee, of which Sir John Russell is chairman, to draw up provisional plans for a similar survey of Britain as a whole.

Thames Floods. On the night of January 6–7, 1928, the low-lying districts of London were inundated by the overflowing of the Thames River, resulting in the loss of a number of lives and of very considerable property damage. Floods in London due to the overflowing of the Thames have a recorded history extending over many centuries and have necessitated the erection and maintenance of flood-protection works. After the flood of January, 1928, a conference was called at the instance of the Prime Minister, and a committee was appointed to study the matter

with particular reference to the broad causes of the disaster, the probability of a recurrence, and the giving of warnings.

The committee reported that the flood of January, 1928, was due to the simultaneous occurrence of a spring high water, a rise in sea level occasioned by strong northwesterly gales over the North Sea accompanied by a westerly gale in the Channel, and the charging of the upper Thames with a very considerable quantity of snow water ("Report of a Committee Appointed at a Conference of Public Authorities to Consider the Question of Floods from the River Thames in the County of London," Ministry of Health, 1928). It was recommended that a technical investigation of the question of abnormal tides in the Thames be undertaken by the Liverpool Tidal Institute and the Meteorological Office.

The report on this investigation appears as a memoir (*British Meteorol. Office Geophys. Memoirs No. 47*, 1929) embodying a "Report on Thames Floods," by Dr. A. T. Doodson of the Tidal Institute of the University of Liverpool, and "Meteorological Conditions Associated with High Tides in the Thames," by J. S. Dines of the Meteorological Office. Dr. Doodson's "Report" comprises a statistical investigation of the correlation between sea level and meteorological conditions, studies of storm surges, of the effects of land water, and of the probabilities of the occurrence of abnormal tides. With regard to the last matter he concludes that a dangerous flood is likely to occur once in about 60 years. Mr. Dines's study relates to the practicability of giving useful warnings of abnormally high tides in the Thames. He finds that certain meteorological conditions over the North Sea generally give rise to a heightened sea level. But for some reason not yet understood there is a marked tendency for the maximum rise of sea level to occur about 3½ hours before high water. He finds, further, that while it would be practicable to issue forecasts of the likelihood of exceptionally high tides the factors involved are not yet sufficiently known to make it "possible to issue useful warnings of Thames floods at the present time."

H. A. MARMER

ASIA

The Aspect and the Place Names of Palestine. Professor Almagià observes at the beginning of the volume "Palestina" (Luciano Morpurgo, Rome, 1930) that no other land has so continuously attracted the attention of civilized men as Palestine. Whoever wishes to gain a general impression of the outward aspect of the country will find that Almagià's book and a recent volume by the Jesuit Father Robert Koeppel (Palästina: Die Landschaft in Karten und Bildern, J. C. B. Mohr (Paul Siebeck), Tübingen, 1930) admirably supplement each other. Both are collections of photographs with subsidiary text. By means of a careful selection of airplane and ground views Koeppel aims systematically to depict the landscape of the various natural regions of Palestine. As an aid to understanding the photographs, a series of diagrammatic maps, diagrams, and reproductions of models makes clear the essential facts of geology and physiography; but no climatic maps are included, probably for lack of sufficient detailed long-range weather records. The book is designed as a preliminary essay toward a modern, scientific, geographical description of Palestine and also as a background for Biblical studies.

The photographs in Almagià's volume, mostly taken by Dr. Luciano Morpurgo, are more artistic and more intimate than those reproduced by Koeppel. Whereas Koeppel takes us to hilltops and high into the air for wide and distant outlooks over bleak mountains and lowlands, Morpurgo shows us gardens and orchards, city streets and crowds, and individual men, women, and children typical of the mixed population. Particularly striking are some of the pictures taken in and about the recent Jewish settlements, whose modernity is in extraordinary contrast with the crumbling age of the land that surrounds them. In the text Professor Almagià

gives a brief and clear account of physical features, flora, history, and economic circumstances.

Of a different character is another volume on Palestine that has also appeared this year. This is Gustaf Dalman's "Jerusalem und sein Gelände" (constituting Vol. 4 of the Schriften des Deutschen Palästina-Instituts, edited by G. Dalman; C. Bertelsmann, Gütersloh, 1930). Written for the historian or scholarly visitor, it gives a detailed historical and topographical description of the hills and valleys, roads and watercourses of Jerusalem and its environs. Primarily concerned with the site of the Holy City, the author deliberately renounces any attempt to discuss its situation in relation to wider geographical horizons. The book is a sort of twentieth-century counterpart of the medieval handbooks on the topography and documents of Jerusalem; but here Biblical passages are interpreted in the light of modern scholarship, of recent archeological and topographical surveys, and even of airplane photographs. The value of the airplane photograph in Palestinian research was made clear by Dalman himself five years ago in the excellent "Hundert deutsche Fliegerbilder aus Palästina" (see *Geogr. Rev.*, Vol. 16, 1926, p. 673).

In the introduction to his "Jerusalem" Dalman discusses existing maps of Jerusalem and its vicinity and gives critical consideration to the thorny question of Palestinian place names. What is true of the topographical nomenclature of this region is doubtless also true of many other parts of the world. In general, a mountain group, a mountain chain, or a long watercourse in hill country is not known to the local population by a name designating the feature as a whole. The peasants' name applied merely to a single hill or portion of a watercourse often appears on modern maps as the general term for the larger feature. Even the ancient names often entered on maps to obviate this difficulty were doubtless applied in antiquity to local objects alone. "Only the peasants know the place names and this only within the circuit of the meadows and woodlands of their villages, even though they may drive their asses daily beyond these immediate confines. And among the peasants, one may rely [for authentic place names] only on the older men—not on the women." Since adequate investigations of place names have not been carried out among the peasants over the greater part of Palestine, existing maps are inaccurate and arbitrary in this respect.

Rice in the Far East. Although the world production of wheat is about the same as that of rice—between twelve and fourteen hundred million quintals—the rice fields of the world cover only about 54 million hectares as compared with the 108 million hectares devoted to wheat culture. Rice, also, has a much more limited range on the world's surface; for 97 per cent of the total crop is raised in the Far East and even there it is confined to the more favorable localities.

Until recently rice countries have been regarded as regions characterized by a monoculture whose crop was absorbed locally. Within the last fifteen years the introduction of industrial agriculture on a large scale and the gradual increase in population and in standards of living have led to the development of an active commerce in rice. A survey of the rice trade of the Far East has been published in the *Bulletin Quotidien* of the *Société d'Études et d'Informations Économiques* (Paris, Nos. 113 and 114, May 23 and 24, 1929). This had been summarized in *L'Océanie Française* (Vol. 25, 1929, pp. 58–62). Another account is that by J. A. LeClerc: Rice Trade in the Far East (*Bur. of Foreign and Domestic Commerce, Trade Promotion Ser. No. 46*, Washington, 1927). A similar survey, chiefly concerned with the results to European rice production of this Far Eastern trade appears in the *International Review of Agriculture, Part II, Monthly Bulletin of Agricultural Economics and Sociology* (Year 20, No. 2, 1929, pp. 53–72).

British India, with the possible exception of China for which accurate figures are unavailable, is the greatest producer and consumer of rice. In 1928, 32 million

hectares were under cultivation. Burma produces most of the surplus, which is largely exported to Ceylon, where local production in competition with an extensive industrial culture is able to care for only one-quarter of the total consumption. In Indo-China exportation is increasing as new means of communication open up the country. Here, rice represents about sixty-eight per cent of the total value of exports (A. Naud: L'exportation des grands produits agricoles indochinois, *Ann. de Géogr.*, Vol. 39, 1930, pp. 50–60). Siam is still an excellent example of a monocultural country, since 90 per cent of the cultivated surface is in rice and 80 per cent of the population is occupied in its production. A population of 56 million people inhabiting a country with but 60,000 square kilometers available for cultivation has forced a Japanese production of 36 quintals per hectare—the most intensive cultivation achieved in the Far East. Java and Madura have attained an average production of 15 to 16 quintals per hectare. A map showing the variation in yield from district to district is given by A. M. P. A. Scheltema in a paper, "Rice Production in Java and Madura," presented before the Fourth Pacific Science Congress held in Java in 1929. Production in Madura is low: the highest yields are obtained in the extreme east of the main island. The introduction of modern methods and machinery on the unirrigated upland rice fields of the Philippine Islands, together with a steady increase of the acreage in paddy, is making these islands more nearly self-sufficient.

Mayon Volcano and Its Eruptions. Mayon is a young volcano lying at the end of the Albay Peninsula, which puts off from the southeastern corner of Luzon Island. It has been in more or less continuous eruption since the Philippine Islands were discovered. The most violent eruption known occurred in 1814; since then there have been 28 eruptions, or an average of one every four years. Some of them lasted only a few hours, some lasted several months. Many were destructive of life and property. The fairly strong eruption in July, 1928, alarmed the inhabitants of the region and led to an examination of the mountain by L. A. Faustino, of the Philippine Bureau of Science (*Philippine Journ. of Sci.*, Vol. 40, 1929, No. 1, pp. 1–48).

The volcano rises about 2421 meters above sea level and covers a roughly circular area about 17 kilometers in diameter, extending on the east to the sea. The heavy rainfall, about 130 inches a year, has cut many deep ravines in its flanks, which do not, however, detract from its wonderfully symmetric form and the beautiful curves of its outline. The symmetry is due to the fact that the eruptions always take place from the crater at the summit and not from openings on the sides. These eruptions consist mostly of ejecta, though lava also wells up in the crater and overflows—at present, especially through the gap that exists on the eastern side. The upper slopes are very steep, 35°–45°, and the lava flows down them at great speed; even at an altitude of 600 meters, where the slope is between 10° and 15°, the lava of 1928 advanced half a kilometer in 12 hours. Faustino notes that in the eruption of 1928 the vegetation around the base of the volcano was injured on the outer side and not on the side facing the crater. The fine dust falling at a distance of some kilometers from the crater is sucked in towards the crater by the eruptions and strikes the vegetation on the outer side; the damage is due to the hydrochloric acid carried on the dust particles. The heated gases, expelled from the crater and heavily laden with fine dust, at one time rose to a height of eight kilometers above the summit in a narrow column and then spread out in the "cauliflower" form. Faustino thinks the explosions must have been very violent to shoot gas and dust to so great a height. The explosions were undoubtedly violent, but convection must have been an additional cause.

Many towns and villages surround the volcano, and Faustino makes some recommendations for the protection of life and property in future eruptions. He recalls how successfully Omori, relying on seismograph records, prevented a great disaster

by causing the inhabitants of Sakurajima to evacuate that island just before the violent eruption of 1914; and he urges the installation of a seismograph near Mayon Volcano to give warnings of a coming eruption.

HARRY FIELDING REID

WORLD AS A WHOLE AND LARGER PARTS

The Mecca Pilgrimage and the Arab World. In the September, 1929, number of the *Geographical Journal* Eldon Rutter gives some figures regarding the annual pilgrimage to Mecca. He estimates the total number of pilgrims in normal years at about 172,000. Of these at least 40,000 hail from Central Africa and the Sudan. "This great trek of Africans," some of whom come from as far as Senegal, Guinea, Sierra Leone, Liberia, "is always going on; only in the countries bordering on the Red Sea does it increase at the pilgrimage season. In Western and Central Africa it never ceases. . . . Thousands die before they can reach Arabia; other thousands die in the Arabian desert on the last stage of their journey. Only a small proportion of them pass through the ports of Jidda and Yenbo. On whatever part of the Arabian coast the dhows are blown by the wind, there the pilgrims are disembarked, the crew show them the direction of Mecca, and on they go." Most of the pilgrims, however, come by easier and surer means. Dutch, British, and Indian-owned steamers bring 30,000 from Malaya, Borneo, and Celebes and 25,000 from India. From Egypt arrive 15,000, "the largest number of pilgrims relative to population." "An Egyptian from any part of the Delta can, by timing his departure with precision, accomplish the Pilgrimage to Mecca and be in his own home again within fourteen days of his departure. If he extends his journey to El Medina he may still be home again within less than four weeks." This is a very different story from that of earlier days, when the journey, even from Egypt, was a long and painful one over deserts and by small sailing vessels.

The remainder of the 172,000 pilgrims is made up as follows: 10,000 from Morocco, Algeria, and Libya; 10,000 from Syria, Turkey, and the Balkans; 6000 from Afghanistan and Baluchistan; 5000 from Kurdistan, Bukhara, and Central Asia; 1000 from China and Cochin China; and 30,000 from Arabia itself. It is noteworthy that there are very few Persians, owing, of course, to the suspicion in which they are held, as Shiahs.

These figures are based largely on personal observations of Rutter, who himself made the pilgrimage as a professing Moslem in 1925. Traveling in the guise of a Syrian, he went first to Massawa, where he chartered a dhow which conveyed him to the Arabian coast at El Gahm in the Yemen. Mecca was ultimately reached toward the end of June, and nine months were spent there, broken by a trip to the upland town of Taif. Medina was also visited before Rutter's final departure from Yenbo, about a year after his arrival in Arabia. He describes his experiences in a two-volume work, "The Holy Cities of Arabia" (G. P. Putnam's Sons, London and New York, 1928; see also the review by "P. Z. C." in *Geogr. Journ.*, Vol. 73, 1929, pp. 460–463, which gives some personal details regarding the author).

Rutter's name is a distinguished addition to the list of Europeans who through the centuries have visited Mecca. In 1904 the late Dr. Hogarth knew definitely of thirteen, not counting various renegades and Levantine Greeks whose presence other travelers had reported (D. G. Hogarth: The Penetration of Arabia, London and New York, 1904, p. 186; see also Augustus Ralli: Christians at Mecca, London, 1909). Since then there have been few others. A young Englishman succeeded in making the pilgrimage in 1909 and had some thrilling adventures (A. J. B. Wavell: A Modern Pilgrim in Mecca, and a Siege in Sanaa, London, 1912). Rutter, however, was so thoroughly schooled in the Arabic language and customs, so steeped in theological traditions of Islam, and so sympathetic with its religious outlook that, even

though it became known that he was an Englishman, his stay in Arabia was on the whole serene. At least such is the impression one gains from the narrative, which gives little hint of imminent danger from the outflaring of fanaticism. This, however, adds to the value of the book. Able to avoid arousing suspicion, Rutter gathered the materials for a work which in many respects stands on a par with the classic descriptions given by Burckhardt and Burton of life in the holy cities of the Hejaz.

An informative and well written recent volume, primarily for the general reader unfamiliar with Arab affairs, is Richard Coke's "The Arab's Place in the Sun" (Thornton Butterworth Ltd., London, 1929). This is a broad survey of the history of the Arab people from the time of Mohammed, with particular emphasis on the modern period. The writer believes that the salvation of the Arabs of Arabia, Iraq, and Syria will come through the development of Arab national feeling and that the British should encourage this movement for their own interests as well as for those of the Arab himself.

Movements of the Jewish Population during the Last Century. Valuable statistics and estimates regarding the Jewish population of the world and its migrations during the past century are given by Jakob Lestschinsky in two recent numbers of *Weltwirtschaftliches Archiv* (Vol. 25, 1927, pp. 69*–86*, Vol. 30, 1929, pp. 123*–156*). The total number of Jews in Europe and Jews of European origin elsewhere in 1925 is reckoned at about fifteen millions, as contrasted with three millions in 1825. The rate of increase represented by these figures, fivefold in a century, as half as much again as that of the population of Europe as a whole and is to be ascribed not to a higher birth rate but to a lower death rate among the Jews. Only about 205,000 Jews were lost through apostasy during the whole nineteenth century.

The last century has also witnessed remarkable shifts in the world-wide distribution of the Jews. Of the two main groups, Sephardim and Ashkenazim, the former, or Jews of Spain, Portugal, Africa, and the Near East, included in 1825 about 600,000 souls, or 18 per cent of all Jews. In 1925 there were some 900,000 Sephardim, but the Ashkenazim of northern, central, and eastern Europe had increased so disproportionately that the Sephardim now comprise barely 6 per cent of the Jewry of the world.

The United States has been the main goal of Jewish oversea migration. At the beginning of the nineteenth century there were only about two or three thousand Jews in America. Now there are 4,000,000 in the United States, 27 per cent of all Jews. The Jewish emigration from Europe to this country during the first quarter of the twentieth century amounted to 1,810,752, or more than a fifth of the total number of Jews in Europe in 1900. No other nationality has sent to us anything approaching such a large proportion of its total numbers. As the return migration of Jews from the United States to Europe has been small, their net immigration into the United States has been relatively greater than that of any other people.

Besides the oversea migration, there has also occurred a notable shifting of the Jewish population westward within Europe. Lestschinsky believes that one half of the "German Jews" at the present time are probably either the children or grandchildren of Jews from eastern Europe.

We are inclined to think of the Jews as almost exclusively city dwellers, but a century ago "about a third of all the European Jews at that time lived in complete isolation, scattered among separate villages, two or three families, or often only one family, to a village. Another third dwelt in communities of less than 500 inhabitants. Their occupations were almost without exception those of small tradesmen," in which capacity they served as middlemen between the peasants and the feudal landholding nobility of eastern Europe. The movement of the Jews to the cities has, perhaps, been the most impressive aspect of the Jewish migrations of recent times. Lestschinsky gives a table showing the Jewish population in all cities having Jewish

communities of over 15,000 in 1920 and draws many interesting conclusions from these and other data. He estimates that 30 per cent of the entire Jewish population of the world now dwells in compact and concentrated groups in large cities. In 1925 80 per cent of all the Jews in the United States lived in 32 communities of more than 10,000 Jews each. New York, with 1,750,000 Jews, is the largest Jewish city in the world; Chicago comes second with 325,000. New York also has a much higher percentage of Jews in the total population than any other city in the United States. The most purely Jewish large towns in the world, however, are still to be found in eastern Europe. Jews constitute over 74 per cent of the total population (23,468) of Pinsk in Poland, 71 per cent of that of Rovno in Poland (30,482), and 65 per cent of that of Berdichev in Ukrainia (43,574).

An impression prevails in some quarters that Zionism aims to establish in Palestine the greater part of the Jewry of the world. Lestschinsky's figures and a more detailed discussion by L. Hersch (La population de la Palestine et les perspectives du Sionisme, *Metron: International Review of Statistics*, Vol. 7, 1928, pp. 115–136) show the absurdity of this idea. Even if there were no other people living there, Palestine could hold only a small fraction of the 15 or 16 million Jews. What is more, it is impracticable to think of establishing even a Jewish majority. When the Census of Palestine was taken in 1922 it showed 673,388 non-Jews and only 83,794 Jews. Jewish immigration into the Holy Land is not flowing in a steady stream but has fluctuated violently. In 1925 33,801 Jews entered, but this great wave was more than the country could absorb. The resulting economic distress forced many of the immigrants to leave, and during the latter part of 1926 and all of 1927 (except April) more Jews were departing than arriving. Hersch thinks it optimistic to look for a net Jewish immigration in the years to come of more than about 5000 or 6000 annually. Since the natural increase of the non-Jewish population is considerably greater (both in relative and absolute terms) than that of the Jews, many more immigrants per year than this would be necessary to place the Jews in the majority, even in the distant future.

PHYSICAL GEOGRAPHY

Raised Marine Terraces in New Zealand and South Africa. Between Wairau River and Banks Peninsula, New Zealand, a series of marine terraces has been distinguished by G. Jobberns (The Raised Beaches of the North East Coast of the South Island of New Zealand, *Trans. and Proc. New Zealand Inst.*, Vol. 59, 1928, pp. 508–570). The terraces occur along the greater part of the coast mentioned but are lacking in small portions—a fact difficult to explain. The altitudes of the members of the series are respectively 40–60 feet, 120–150 feet, 230–250 feet, 330–380 feet, 500–525 feet, 650–700 feet, 800–900 feet, and 1000–1200 feet (estimated). The inner edges of the terraces, when traced over several miles, are not regular in height; the outer margin may occasionally be as much as 150 to 200 feet higher than the inner edge; and the surface cover may have a pronounced landward tilt.

The terraces cannot at present be correlated with pre-Quaternary and Quaternary stages distinguished in New Zealand: but their approximate agreement in altitude with terraces on the Mediterranean suggests, in Jobberns' mind, that they may be of the same age; that those up to 380 feet are Quaternary and those at higher levels are Pliocene. The New Zealand terraces are also correlated with the South American terraces as described by Charles Darwin.

Jobberns explains the terraces largely by differential movements between adjacent earth blocks, small compared with the widespread emergence. This emergence may have been due partly to an isostatic response to unloading on the melting of the Pleistocene glaciers and partly to regional deformation of the earth. The part played by changes of sea level, due to fluctuations in the relationship of water and ice, is difficult to estimate.

Jobberns' study is valuable because it includes a new area, New Zealand, among the parts of the globe in which Pliocene and Pleistocene terraces of about the same altitudes are recorded. Important regions, not mentioned by Jobberns, are the Atlantic and Gulf coasts of the United States. In the opinion of W. J. Sollas, Georges Dubois, and the reviewer (Ernst Antevs: Quaternary Marine Terraces in Non-glaciated Regions and Changes of Level of Sea and Land, *Amer. Journ. of Sci.*, Ser. 5, Vol. 17, 1929, pp. 35–49) the four lower terraces on the Mediterranean and in North America date from the preglacial and the three Pleistocene interglacials. In the reviewer's opinion they suggest that the regions have risen different amounts and that, because of sinking of the ocean floor, the sea surface has undergone a progressive lowering besides eustatic fluctuations with the waxing and waning of the ice sheets.

That great caution has to be exercised in correlating raised terraces from different parts of the world becomes evident from A. V. Krige's study of the terraces on the coast of South Africa (An Examination of the Tertiary and Quaternary Changes of Sea-level in South Africa, with special stress on the Evidence in Favour of a Recent World-wide Sinking of Ocean-Level, *Annals Univ. of Stellenbosch*, Vol. 5, Section A, No. 1, 1927, pp. 1–81). In South Africa there are extensive terraces at altitudes of 4000, 2500, and 1000 to 800 feet and smaller terraces at roughly 550 to 450 and 250 to 150 feet. All five terraces are of Tertiary age, the last three being partly covered by a sheet of Mio-Pliocene sediments. They were formed during regression of the shore line, a regression continued below the present position, to at least the isobath of 300 to 330 feet and possibly much farther. Emergence was due mainly to upheaval of the land and partly to eustatic lowering of sea level during the Pleistocene.

This Tertiary-Quaternary emergence was followed by a Quaternary, but not more closely dated, immergence whose upper limit is marked by impressive shore features at an average altitude of 50 to 60 feet and was probably due to sinking of the land. Whether this terrace is a correlative of the Monastirian terrace on the Mediterranean and Jobberns' 40 to 60-foot terrace in New Zealand is doubtful. The next and last great event deciphered by Krige is regression of the shore line from the 50 to 60-foot terrace to the modern stand. This emergence has left marked shore features at 20 and 14 to 12 feet altitude. The 20-foot terrace was formed during a time of warmer water than at present, as shown by shells in its deposits. It is explained after R. A. Daly by higher stand of sea level due to shrinking of the ice sheets during the postglacial temperature maximum, which prevailed from about 7000 to about 3000 years ago.

The importance of Jobberns' and Krige's papers is augmented by their appearing at a time when the terraces in Europe and adjacent Africa and Asia have been taken up for an intensive study (First Report of the Commission on Pliocene and Pleistocene Terraces, edited by K. S. Sandford, *Internatl. Geogr. Union Publ. No. 2*, Oxford University Press, 1928).

ERNST ANTEVS

Stream Flow Studies and Climatic Cycles. Recently two members of the American Society of Civil Engineers independently have published results of studies of stream flow and water levels which reveal distinct correlation with the sunspot cycle. A. Streiff, in "The Practical Importance of Climatic Cycles in Engineering" (*Monthly Weather Rev.*, Vol. 57, 1929, pp. 405–411), discusses the average flow of various rivers and the levels of various lakes, particularly the Great Lakes. He points out that the run-off of streams shows cycles much more clearly than do rainfall records and that many curves of stream flow correlate clearly with the sunspot cycle, with twice that cycle, or with the Brückner cycle (three times the sunspot cycle). This is because the run-off is cumulative and increases three times as fast as the rainfall.

Accompanying such cyclic variations in run-off, the lake levels vary cyclically. For the Great Lakes there is a lag of one-quarter period behind the Brückner cycle. The 11-year sunspot cycle also is clearly shown in the levels of the Great Lakes. The past year (1929) was a maximum; another about a foot higher is predicted for about 1940. Streiff's summary is, in effect, that, although recent climatic cyclic changes have too small amplitudes to be of any considerable importance in forecasting the weather of eastern United States, nevertheless, owing to the cumulative as well as the amplifying nature of stream flow, they are of great importance in hydraulic engineering. Correlation between Wolf's sunspot numbers and stream flow can be utilized to good effect in engineering projects involving large investments.

A. Sonderlegger, in the issue of the *Monthly Weather Review* for September, 1929, shows that in the Los Angeles, Cal., area, although the rainfall is so erratic as seldom to be thought to show a correlation with the sunspot numbers, nevertheless when the successive years are grouped in a certain way such a correlation appears. But since the run-off varies much more than rainfall, Sonderlegger finds, as did Streiff for Michigan rivers, a distinct correlation between stream flow and the sunspot cycle. The level of ground water fluctuates correspondingly.

S. S. VISHER

GEOGRAPHICAL NEWS

Woods Hole Oceanographic Institution. Announcement has been made of the incorporation of Woods Hole Oceanographic Institution for the study of the sea. The institution was conceived by the Committee on Oceanography of the National Academy of Sciences, and its establishment was recommended to the Academy as a most effective method of advancing knowledge of the sea. Modern oceanography is a highly complex science, offering a field of investigation to biologists, physicists, chemists, and meteorologists and depending, in turn, upon all of these for the solution of its particular problems. (Henry B. Bigelow: A Developing View-point in Oceanography, *Science*, No. 1830, Vol. 71, 1930, Jan. 24, pp. 84–89). To the geographer in particular the ocean represents a source of man's food, an important climatic control, a barrier to migration, and the pathway of much of the world's commerce.

The location of the institution was decided upon both because of the proximity of two important marine biological stations and because of the variety of problems present there. The transition from inshore to offshore waters is rapid, the temperature of the water varies greatly with season and location, there is a diversity in the configuration of the ocean bottom, and the nearness of the Gulf of Maine provides an excellent opportunity to study the relationship between physical-chemical and biological problems of oceanography. A noteworthy feature of the equipment of the organization is a moderate-sized, ocean-going vessel capable of making extended scientific voyages.

The Rockefeller Foundation has appropriated funds sufficient to insure an adequate building program and operating expenses, and the new institution plans to open its doors by the summer of 1931. Dr. Henry B. Bigelow, of the Museum of Comparative Zoölogy, Cambridge, Mass., will be director of the new institution; and its board of trustees, of which Dr. Frank Lillie is president, includes many distinguished scientists.

GEOGRAPHICAL REVIEWS

Tectonic Studies in Asia

J. W. Gregory, edit. **The Structure of Asia.** xi and 227 pp.; maps, diagrs., ills., bibliogrs., indexes. Methuen and Co. Ltd., London, 1929. 15 s. 7½ x 5 inches.

J. S. Lee. **Some Characteristic Structural Types in Eastern Asia and Their Bearing upon the Problem of Continental Movements.** Maps, diagrs., ills. *Geol. Mag.*, Vol. 66, 1929, pp. 358–375, 413–431, 457–473, 501–522.

Since the publication of "Das Antlitz der Erde," by Eduard Suess, the attention of geologists has been focused upon the magnificent display of mountain belts afforded by the relief map of Asia. Unfortunately the details of structure in most of these mountain units have been and still are little known; and accordingly the syntheses of Asiatic structure that have been attempted employ assumption and speculation on a large scale. An example is the well known treatise "La Tectonique de l'Asie," by Émile Argand (*Comptes Rendues Congrès Géol. Internatl. XIII, en Belgique, 1922*, fasc. 1, Liége, 1924, pp. 171–372). Argand's estimate of the crustal shortening involved in the Tertiary folds and thrusts of Asia can be little more than a guess, since in very few Asiatic mountain zones has the shortening been determined with any accuracy. The bold and somewhat poetic conceptions of Argand are valuable if their speculative character is kept in mind; but at the present time the need is for additional facts rather than generalizations regarding the geology of Asia.

The book edited by J. W. Gregory has the merit that it presents many new data from recent field study. The title is somewhat misleading, since for the most part the book deals with limited sections of the continent and attempts only a sketchy general treatment of the major structure. Besides an introduction by the editor there are seven chapters, written by different authors and relating to different regions. Most of these chapters are brief abstracts; but Chapter 3, which describes the stratigraphy and structure of the Iranian ranges, occupies more than half the total space and includes a wealth of detail. This material, collected by geologists of the Anglo-Persian Oil Co., is presented with valuable cross sections and a tectonic sketch map. It is shown that the ancient mass of Arabia has played the rôle of foreland, toward which folding and thrusting movements have been directed from the northeast. The deformed zone consists of two general belts. Adjacent to Arabia sedimentary formations, ranging in age from Paleozoic to Tertiary, are strongly folded but not affected in any large measure by thrust displacement. This belt merges northeastward into the "zone of the nappes," in which similar formations are involved in large thrust sheets. Still farther toward the northeast the intense deformation dies out, and the strata record only vertical uplift with warping. This large block is referred to as the "median mass," in view of its position between the Iranian ranges and the Elburz Mountains near the Caspian Sea. "Median mass" is used instead of the term "Zwischengebirge" employed by Kober and others.

In another chapter F. E. Suess, of Vienna, discusses "The European Altaids and Their Correlation to the Asiatic Structure." He notes that ideas have changed greatly with increasing information since his father's famous synthesis appeared; and he shows that the trends of the European late Paleozoic folds are various and in great measure dependent on "intrusion tectonics," a term he applies to disturbance caused by igneous intrusion. Like Argand, F. E. Suess thinks the older tectonic blocks have been caught up and tossed about in more recent movements with the result that the present trends afford no safe criterion as to the original trend lines.

D. I. Mushketov contributes a short chapter in which he outlines the structure of the East Ferghana-Alai Range in Turkestan. W. D. West records the finding by the Geological Survey of India of important thrusts in the northwest Himalaya. George B. Barbour discusses the structural evolution of eastern Asia, paying particular attention to the history and distribution of geosynclines and outlining the principal episodes of folding. C. P. Berkey presents a concise résumé of tectonic events in the Gobi region. A short note by H. A. Brouwer states the evidence for horizontal movements in the East Indian Islands. Gregory, in his Introduction, attempts to apply the new information as a test of Argand's and other current hypotheses and expresses a preference for the older ideas of Eduard Suess regarding the major framework of the continent. In spite of the fragmentary and loosely knit character of the book as a whole, it is to be welcomed as an actual contribution to our knowledge of Asia.

The paper by J. S. Lee discusses the structure of the eastern part of the continent, including the island arcs from the Kuriles to the East Indies. The whole emphasis, however, is placed on the trends of mountain units, to the exclusion of cross-sectional studies. He presents a sketch tectonic map of Eastern Asia and points out five east-west belts of folding, spaced uniformly eight degrees apart, which he suggests indicates a fundamental control. He even professes to see a similar spacing in other continents; but the critical reader is not impressed with his enthusiasm on this point. Obviously the belts selected are far from equal in value as tectonic units, and they do not maintain strict parallelism. Moreover, since these belts represent widely separated dates of folding, it is especially difficult to conceive any logical reason for a strictly geometrical arrangement. The intersection of two general trends, the one generally east-west and the other parallel to the Pacific border of the continent, is brought out strikingly on Lee's sketch. This general arrangement has been noted many times and is a strong argument for some kind of conflict between the continental and oceanic blocks of the crust.

Lee analyzes the arrangement of trend lines in further detail and professes to recognize seven distinct types of fold pattern. By means of simple experiments, in which he used tracing cloth soaked in soapy water, Lee succeeded in imitating these patterns in miniature. The experiments are ingenious and suggestive; but, when Lee deduces from them the character of movement suffered by Asia as a whole and even includes other continents in sweeping conclusions, the reader is left cold. Surely this is unwarranted generalization from slight evidence.

The chief effect of papers like Lee's is to strengthen our desire for more facts about the geology of Asia. The pattern of mountain belts shown on the relief map is highly suggestive and leads us to think that Asia has much to contribute in the search for the fundamental meaning of mountain structure. Surely the pattern of trend lines is significant and deserves much emphasis in a comprehensive study; but even the direction of the important structure lines cannot be deduced with any assurance from a relief map, and any attempt to make sweeping generalizations without full knowledge of the structure can result in no more than interesting guesses.

CHESTER R. LONGWELL

CLIMATIC REGIONS OF CHINA

COCHING CHU. **Climatic Provinces of China.** 11 pp.; maps. *Memoir Inst. of Meteorol. No. 1.* Institute of Meteorology, National Research Institute, Nanking, China, 1929. 10½ x 7½ inches.

The Institute of Meteorology of the National Research Institute at Nanking, under the direction of Coching Chu is rapidly making a name for itself in the meteorological world. Regular monthly meteorological bulletins; an increasingly widespread and

efficient organization of meteorological stations; the publication of daily weather maps and the issue of daily forecasts—these and other activities of the Institute are attracting sympathetic and appreciative attention. And now its first Memoir appears. This is by Dr. Chu and deals with the climatic provinces of China. Concerning classifications of climate it may truthfully be said that there is no end. But, as Dr. Chu rightly points out, "no climatic subdivision has ever been devised specifically for China from the purely meteorological point of view," although there are, of course, many schemes of climatic provinces or subdivisions which include China as a portion of Asia or of the world as a whole. He considers critically, as applied to China, the climatic provinces suggested by Köppen and de Martonne and also the six types which Jules Sion, of the University of Montpellier, has recently suggested in his "Asie des Moussons" (1928).

Taking account of temperature and precipitation and the annual distribution of these two elements; also having in mind the importance of a classification whose divisions shall agree with the natural regions and, if possible, with the political units of the first order and which shall in addition take account of cyclonic and anticyclonic controls, Dr. Chu offers "for consideration" a series of eight major climatic types. These are, respectively, South China, Central China or Yangtze Valley, North China, Manchurian, Yunnan Plateau, Steppe, Tibetan, and Mongolian. The essential characteristics of each type are clearly set forth. To take as an example the Central China or Yangtze Valley type. The mean temperature of the winter months is below 10° C. The northern boundary is the November isotherm of 10°, that is there are at most four months with a mean temperature below 10°. The mean annual range varies from 18° to 25°. The rainfall is over 75 centimeters. Extratropical cyclones frequent the region in winter and spring. The winter is therefore comparatively wet, and "plum rains" occur from April to June. Typhoons reach this section in July and August only, but their effects do not extend far inland. Temperate tropophytic forests are found, and most of the tea produced in China grows here. Those who are already familiar with the climates of China will realize that this is an excellent, although necessarily very brief, summary for the Yangtze Valley region. Similarly compact summaries are given for the remaining provinces.

The paper contains colored charts of Köppen's, de Martonne's, and Chu's climatic provinces; a colored rainfall map of China (after E. Gherzi); mean annual, January, and July isothermal maps (after H. Gauthier), and a hypsometric map.

R. DeC. Ward

China and Her People

L. H. Dudley Buxton. **China, the Land and the People: A Human Geography.** With a chapter on the climate by W. G. Kendrew. xiii and 333 pp.; maps, ills., index. Clarendon Press, Oxford, 1929. $5.00. 9 x 6 inches.

Georg Wegener. **China: Eine Landes- und Volkskunde.** 233 pp.; maps, ills., bibliogr. B. G. Teubner, Leipzig and Berlin, 1930. Mk. 12. 8½ x 6 inches.

Although these two volumes are very similar in title, the treatment is quite different. Buxton writes as an anthropologist and is interested in the people and their activities, especially agriculture. Wegener devotes considerable attention to the geographical setting of the country but is chiefly interested in the recent history of China. The volumes may be described as worth-while contributions to our understanding of China, though neither is as original, or comprehensive, or penetrating as one might wish.

A striking deficiency in each volume is the absence of good maps and the obsolete political treatment. Buxton states in his preface that he prefers to follow the old provincial alignment, since some of the "new provincial names do not at present

appear in foreign atlases"; and yet many of these changes are of more than twenty years standing. Both authors mention most of the new provinces, but neither shows their correct locations. The map of China has been undergoing many changes in recent years and is perhaps not stabilized yet. The layman may be excused for not keeping up with these developments, but books which are to serve as standard reference volumes should furnish a reliable guide to current conditions.

Both authors follow rather loose regional treatments in their description of the physiography, but neither clearly defines the boundaries or characteristics of the regions. Wegener discusses six regions in North China, which reaches south to include the Yangtze Delta, and three regions in Middle and South China, which extends as far north as the basin of Hunan and Hupeh along the middle Yangtze. Such a division between north and south by a line at right angles to the Yangtze has neither physiographic, climatic, nor human significance. The regional treatment of Buxton is likewise not precise, for he includes the level land around the Tungting Lake (incorrectly spelled Tuting) and the valley of the Han Kiang with the mountains of Kweichow in one section entitled "Kweichow and Neighboring Regions."

The statements of Buxton with regard to the homogeneity of the Chinese race appear to be contradictory, for on page 44 he states that "the Chinese themselves today seem from the scanty data available to present a more or less homogeneous ethnic type" and "the physique of the people is . . . extraordinarily homogeneous," while on page 161 he writes "there is no such thing as a Chinese ethnological type, for the Chinese represent a mixture of many different stocks." Certainly the last statement is much nearer the truth. Buxton's discussion of the physiography is placed at the end of the book rather than before the treatment of agriculture, thus tending to divorce the environmental factors from their influence on the people. The book closes with an excellent chapter on the climate by Kendrew.

About one-fourth of Wegener's book is devoted to the history of China since the beginning of the nineteenth century. His method is illustrated in his excellent treatment of the Great Wall where the recent military maneuvers of Chang Tso Lin, the former Manchurian war lord, at Shan Hai Kwan are mentioned in connection with the location of the Wall.

Both books contain exceptionally good illustrations and are well written, and their semipopular character should insure a wide reading.

GEORGE B. CRESSEY

SVEN HEDIN'S WORK IN TIBET

EMMANUEL DE MARGERIE. **L'oeuvre de Sven Hedin et l'orographie du Tibet.** 139 pp.; maps, diagrs., ills., index. Extract from *Bull. Section de Géogr. du Comité des Travaux Hist. et Sci.*, 1928. Imprimerie Nationale, Paris, 1929. 10 x 6¼ inches.

Professor de Margerie pays his compliments to Sven Hedin as one of the greatest explorers of all time. The designation comes suitably enough at the end of this short volume and after a thorough analysis of "Southern Tibet: Discoveries in Former Times Compared with my Own Researches in 1906–1908," the nine volumes of over 3700 pages that contain the results of Hedin's explorations.

The need for such an analysis is very great for a threefold reason: the volumes are sold for so high a price that few scholars have access to them; Hedin's activities during the war alienated his former friends and led to scant notice of his important work; and the results published hitherto are scattered through publications in several languages.

It is the particular virtue of de Margerie's analysis that he supplements the views and judgments of the original with evaluations and comparisons, comments, footnotes, and corrections of his own. He edits the work of Hedin in the same critical

way that he handled the monumental work of Suess, which made "La Face de la Terre" an even greater edifice than the original. There are reproduced a few maps and sketches, a key to the millionth sheets of the regions covered by Hedin, and all of the field routes. A long series of black-and-white sketch maps shows the development of knowledge respecting the orographic lineaments of Tibet from 1733 to Hedin's own voyage of 1922. The descriptions of the topographical discoveries are reduced to the proportions of the time and understanding of one who wishes to follow Asiatic exploration but has not the expert's interest, so to speak, in boundless, in fact almost monumental, detail. The geological interpretations are also reduced to handy text proportions. But it is not condensation merely that de Margerie's volume has supplied: its greater value lies in the comments upon Hedin's work, and in this respect alone it stands as a model critique.

Mineral Resources of Northeastern Asia

E. E. Ahnert. **The Minerals of Northern Manchuria (Poleznye Iskopaemye Severnoi Manchurii).** 236 pp.; maps, ills., bibliogr. (Manchuria Research Society publication.) Typographical Division of the Chinese Eastern Railway, Harbin, 1928.

E. E. Ahnert. **Mineral Riches of the Russian Far East (Bogatstva Nedr Dalnego Vostoka).** xii and 932 pp. (including English summary of 36 pp.); maps, ills., bibliogr., index. Knijhnoe Delo Co., Khabarovsk and Vladivostok, 1928.

No one is better qualified to advance general knowledge of the mineral resources of northeastern Asia than the veteran mining engineer and geologist who presents in these two books the results of a lifetime of research and personal investigation. In the first-named a mass of detailed information is brought together regarding the mineral resources of a region that has hitherto been the subject only of vague generalizations, occasional partial studies, and scattering official statements. The form of the publication is similar to that of "Minerals of the Far East" (Poleznye Iskopaemye Dalnego Vostoka), issued, under direction of P. I. Polevoy, by the Geological Committee of the Far East in 1923. Its central feature is a list of locations of various minerals, with indications as to the character of the deposits and classification by categories ranging from actual exploitation to unverified reports. In addition to commentaries on the facts thus presented, the author has incorporated a valuable geographical and geological sketch of the region, illustrated by maps and numerous photographs.

Thoroughly as the work has been done, it must be admitted that the results are far from impressive as to either the completeness or the significance of the information set forth. The account is admittedly provisional, owing to the slight degree to which the country has been prospected; about half of the 551 locations listed are rated in the lowest, most questionable category, while many others are already ascertained to be of no industrial value. The only metal known to exist in important quantities is gold, mainly encountered in placer deposits. These appear to correspond in richness with the deposits found on the Russian side of the Amur valley. More than 170 locations are listed, and the reserve is estimated at 3779 metric tons. Of 34 locations of silver-lead ores, none have been proved; but the structural similarity between the Barga plateau and the mountain region of Trans-Baikalia gives grounds for expecting the discovery of deposits like those which supported the old Russian workings in the latter territory. Too little is known about the 27 occurrences of iron ore registered to make possible even a guess at the reserves. The most promising of these, both as to location and character, are in the Siao-lin group, lying along the railway eastward of Harbin. These appear to comprise both Archean crystalline hematite and contact metamorphic hematite. Their probable volume, while not comparable with the

well known deposits of southern Manchuria, is considerable, and the quality of the ore appears superior to that now yielded by the latter.

No coal beds are present approaching in size the famous Fushun field of southern Manchuria. In fact, the entire known industrially practicable deposits are estimated at only 180,000,000 tons. The principal ones being worked are the brown coal Chalainor field, west of Hailar, and the upper Jurassic bituminous beds of the Muren basin, east of Harbin (the Muling mines). The Ho-kang bituminous deposits in the lower Sungari basin are larger but more difficult of access. The coking qualities of these coals are undetermined. Among other non-metallic substances, only building materials and soda-salt lakes offer important possibilities.

The incompleteness of exploration, on the one hand, and the established existence of metallogenetic and coal-bearing zones, on the other, lead the author to expect the discovery of much larger resources than have so far been located. Apart from such possibilities, the most favorable general conclusion he can reach is that enough minerals exist in northern Manchuria to supply the region itself for a long time to come. But even this conclusion may be subjected to the qualification that the establishment of conditions permitting development of these resources would be likely to increase requirements beyond his calculations.

The book is copiously illustrated with photographs and well supplied with maps. The most serious criticism to be made in this connection is that the key map of locations is too small and dimly printed, falling greatly below the standard set by the model publication referred to above, which in certain other respects is surpassed. Since this review was prepared "The Minerals of Northern Manchuria" has appeared in English and Chinese as No. 7, Series A, of the *Memoirs of the Geological Survey of China* (1929).

The second volume under review covers in part the same ground as Polevoy's publication mentioned above but omits the Trans-Baikal and Kolyma-Indigirka regions in the interior. A general map is included on a scale greatly reduced from Polevoy's.

The information provided is fuller and more recent than in the older publication, but the total results are not greatly different. Estimates of reserves of minerals are such uncertain matters that it is not particularly significant to find Ahnert in this publication giving a figure of 779 million tons for the continental coal reserves in place of his own earlier one of 795 or of Polevoy's 755. The present estimate of 556 million tons for Russian Sakhalin Island represents an attempt at precision based on the known facts; a possible figure of over two billion is also admitted. More than half of these possible deposits are now designated as Cretaceous instead of Tertiary; on the continent, likewise, certain series have been assigned to earlier strata than formerly, though none of any consequence falls below the upper Triassic. All the seams are much dislocated, except the Tertiary on Sakhalin, and the type of coal is variable within single seams. A high proportion is coking coal. The Suchan field, east of Vladivostok, containing coals of high quality ranging from semi-anthracite to gas coal, leads in production, although extensive deposits of lower grades, including great beds of brown coal, have been located and are being worked throughout the southern end of the Ussuri region. The brown coal fields of the Amur region are of significance for the railway and the river commercial fleet.

Of the known coal resources it may be predicted that those of Sakhalin are destined, subject to the development of good harbors, for exportation on a large scale. Prospecting and exploitation of the oil fields of the island have not been appreciably advanced since the Japanese occupation, but Ahnert does not believe they are sufficient to play any great part in the world market. The continental coal resources are sufficient to assure the calculable local needs for over three centuries, even providing for the development of a metallurgical industry.

The possibility of such a development is offered by the ascertained existence of

iron ore deposits estimated in the neighborhood of 10,000,000 tons. The contact metamorphic magnetite deposits of the Olga district, on the coast of the Sea of Japan, are strategically located with reference to both the Sakhalin and Suchan coal mines. The hematite deposits of the Little Khingan region near the Amur are larger—nearly 5,000,000 tons—and are also within reach of coking coal beds. Fluxes and alloys are available in the area. The only important non-ferrous deposits other than gold which have been verified are the silver-lead-zinc ores found mainly in the southern Ussuri region along the coast. The Tetiukhe mines, with probable resources of over 700,000 tons, have been worked since 1906, and an ore reduction plant opened in 1914 promises a considerable development when revived and completed to produce richer concentrates.

As in northern Manchuria, the resources in gold are the most considerable, being calculated as between 3833 and 9199 tons. Almost all parts of the territory are gold-bearing, attaining an extent twice as great as all the gold-producing areas of the remainder of Russia. Even in their low state of development these fields have yielded one-third of the total Russian product, and in the regions most actively exploited there are still huge untouched placer deposits, not to mention ore locations whose prospecting and working has hardly begun. It is not possible to indicate here any details in respect of this subject, to which more than a third of the text is devoted.

The survey presented justifies the conclusion that the Russian Far East offers considerable possibilities for the development of mining industries. And, as in northern Manchuria, there remain incalculable prospects of further discoveries, since only an insignificant proportion of the territory has been adequately investigated.

J. V. Fuller

Results of the De Filippi Asiatic Expedition

G. Dainelli and O. Marinelli. **Le condizioni fisiche attuali.** xi and 479 pp.; maps, ills., bibliogr. (Relazioni scientifiche della Spedizione Italiana De Filippi, nell'Himàlaia, Caracorùm e Turchestàn Cinese (1913–1914), Ser. 2: Resultati geologici et geografici, Vol. 4). Nicola Zanichelli, Bologna, 1928. 12 x 9 inches.

Giorgio Abetti and Alberto Alessio. **Geofisica, gravità e magnetismo.** 218 pp.; maps, diagrs., ills. (Relazioni scientifiche della Spedizione Italiana De Filippi, nell'Himàlaia, Caracoràm e Turchestàn Cinese (1913–1914), Ser. 1: Geodesia e geofisica, Vol. 2.) Nicola Zanichelli, Bologna, 1929. 12 x 9 inches.

The region studied in "Le condizioni fisiche attuali" is in the Karakorum Range and the western Himalayas. The former is much the more accessible, and most of the observations are confined to it. The volume is divided into four parts, which will be taken up in order.

The first part is a catalogue of the glaciers of the Karakorum. The total number of glaciers in this range is about 536; but many are small and unimportant; about 30 are described individually. A sketch map showing the locations of the glaciers would be helpful to the reader, but it is lacking. Many of the large glaciers occupy longitudinal valleys, but not all. Five of them are over 50 kilometers long; the Siachen, the longest, is 75 kilometers, and is considered the longest glacier in the world outside the polar regions. The collecting grounds are dominated by high peaks, some between 7000 and 8000 meters in altitude. The tongues extend far into gently sloping valleys with steep sides. With the exception of the Rimu they carry large moraines which spread over the whole breadth of the glaciers for many kilometers from the ends. The twenty largest glaciers end at altitudes varying between 2500 and 4700 meters. Dainelli considers the altitude of the end an important characteristic of the glacier. The proportion of the region covered with ice

and snow increases with the altitude but diminishes to the southeast in spite of the greater elevation.

The second part deals with the snow line. This limit is treated at great length; all the literature is reviewed and discussed. The attempt is made to find a "normal" snow line, independent of topography and exposure. The lack of sufficient observations in the Karakorum and the western Himalayas leads to the adoption of the average of the height of the highest peaks dominating the reservoir and the lower end of the glacier as the altitude of the snow line. It is asserted that this will give a good value if all kinds of glaciers are used; but it cannot be considered very satisfactory and evidently introduces errors. The ratio of the areas of the reservoir and the dissipator is an interesting quantity; in the Alps it averages about 3:1; in the Karakorum Dainelli makes it about 1:1; on some of the glaciers of Mt. Adams, in Washington, the reviewer found a ratio of 1:3 (*Zeitschr. für Gletscherkunde*, Vol. 1, 1906–07, p. 131). This ratio depends, like the snow line, on many factors. Dainelli thinks the ratio 1:1 applies to the Alps also, but glacialists in general would not agree with him. The heavy coating of moraine on the glaciers of the Karakorum adds undoubtedly to the area of the dissipator by reducing the rate of melting.

The third part, after a long discussion on the classification of glaciers, takes up the characteristics of the Karakorum glaciers. Measures of the velocity have not been systematic, but a few observations show that the velocity compares with that of the glaciers of the Alps, namely, from something over a meter a day in the center to a few centimeters near the sides. The ablation at an altitude of 4000 to 5000 meters is about 6 or 7 centimeters a day. Moraines are again discussed.

The most remarkable characteristic of these glaciers, mentioned by many travelers, is the shaping of the surface into peaks and pinnacles. They are very general and are found both on the clean surface of the ice and on the moraines. On the moraines they are less common but are more striking, as they stand up with nearly vertical sides tens of meters in height; and their white ice contrasts strongly with the dark surrounding moraine. Dainelli thinks that streams have had much influence in producing these forms on the clean ice and that irregular melting has developed cones under the moraines, which later became clean when their covering slid off. But this explanation is insufficient to account for pinnacles as high and as steep as a church spire. The Mer de Glace, opposite the Montanvert, is somewhat suggestive of the Rimu, and Tyndall has figured a spire on the lower Grindelwald glacier, though he does not give its size (John Tyndall: The Glaciers of the Alps, London, 1860, p. 14).

The fourth part describes some special physical conditions in the region under consideration—the freezing of the streams in winter, the great mud avalanches that rush down the valleys, and some special forms of erosion; also the hot springs, which are fairly abundant in these high valleys.

Nearly the whole volume was written by Dainelli, as Marinelli died a year and a half before the publication. It is a mine of information about the topics considered. It is not restricted to the observations of the Italian expedition but relates and discusses everything that has been written on the region or on the phenomena observed there.

The volume "Gravita e magnetismo" treats of the methods and results of the Italian expedition in this field. The gravity observations were, naturally, not absolute but relative. Eight half-second pendulums were swung. They were checked at Genoa before starting and after the return; and the results were also compared with the values obtained at the base station of Dehra Dun by the Indian Trigonometrical Survey and at Tashkent by the Russians. The pendulums were swung at twelve other stations. The observations are all given, and the corrections carefully discussed. They were not reduced in accordance with the principle of isostasy, because Alessio does not accept this principle. He reprints a paper first published

in the *Rivista Marittima* in 1922, in which he set forth his objections to isostasy as developed by Hayford and suggests another method by which partial isostasy might result. But his ideas do not accord with what we know of the geological history of mountain ranges.

The magnetic elements were determined at the same stations used for gravity measures. The instruments used and the corrections applied are all carefully described. The results are compared with determinations of the Department of Terrestrial Magnetism of the Carnegie Institution in 1909 and show no discrepancies. The results are valuable but do not indicate any extraordinary conditions in the region visited.

HARRY FIELDING REID

THE REGIONS OF WESTERN AND CENTRAL ASIA

RAOUL BLANCHARD. **Asie Occidentale;** FERNANDE GRENARD. **Haute Asie.** 394 pp.; maps, diagrs., ills., bibliogr., index. (Géographie Universelle, publiée sous la direction de P. Vidal de la Blache et L. Gallois, Vol. 8.) Librairie Armand Colin, Paris, 1929. 100 fr. 11½ x 8 inches.

No attempt is made to correlate the two distinct books included in this volume. Both authors, however, employ essentially the same method, modifying it in accord with the differing characters of the two great tracts with which they deal. Western Asia and High Asia are divided into natural regions and sub-regions, for each of which are disclosed the outstanding circumstances of physical environment, of human life, and of the relations between them. The basis of treatment is thus a regional, or—we might say—"vertical," subdivision. Each author, accordingly, devotes as little space as possible to generalizations applicable to his area in its entirety. Blanchard stresses in three introductory pages the unity of Western Asia arising from the prevalence of an arid climate and of a "powerful rhythm of seasonal migration throughout its length and breadth." He then explains in a brief chapter the geological structure as expressed in the relief features of Western Asia as a whole, and Grenard does the same for High Asia. But beyond this everything is discussed in connection with the subordinate regions.

The latter vary greatly in extent. Grenard calls attention to a remark of Montesquieu that "la nature a coupé l'Asie en plus grands morceaux que l'Europe." Except, perhaps, for Caucasia and parts of Syria this is certainly true of all the territory described in the volume under review. In Tibet, for instance, "despite the immensity of the area, despite the difficulty of communications and the lack of administrative centralization, dialectical differences and variations in manners and customs are less marked than in the France of earlier times," and the same may be said of the other two major divisions of High Asia: Mongolia and Chinese Turkestan. As contrasted with High Asia, however, Western Asia displays a greater degree of fragmentation, outside of the vast, uniform expanses of the Arabian desert. Hence Blanchard can mark off seven major regions (Caucasia, Asia Minor, Armenia, Iran, Arabia, Syria, and Mesopotamia) as compared with Grenard's three and can break these, in turn, into much smaller pieces than those into which Grenard splits Mongolia, Chinese Turkestan, and Tibet. While Grenard gives for the whole of each of his three major regions a general account of population and of economic, social, and political conditions, Blanchard finds it more effective to discuss these topics in relation to the lesser divisions of his seven major regions.

Products of thorough, careful scholarship, both "Asie Occidentale" and "Haute Asie" are phrased in the lucid and picturesque style characteristic of modern French geographical literature at its best. The volume is splendidly illustrated with photographs and maps, and full bibliographical references are given. Two especially attractive maps in color show physiographic and vegetational forms.

The regional method is in accord with the general policy of the series "Géographie Universelle" and with the teachings of one of its founders, the late Professor Paul Vidal de la Blache, who illustrated the method so admirably a generation ago in the now classic "Tableau de la Géographie de France." One surely gains a far better idea of nature and life in a region such as Azerbaijan where everything concerning Azerbaijan is coherently presented in one place than where relief, climate, vegetation, and human geography are each described in separate chapters. On the other hand, the regional method has certain inherent disadvantages. From the stylistic point of view it necessitates repetition. More serious is the danger that regional diversities may be overemphasized, while larger unifying relationships are overlooked or slighted. In general, Blanchard and Grenard have avoided these difficulties and, instead of a patchwork of separate pictures of the different regions of Western and Central Asia, have succeeded in giving us two unified compositions in which the dominant tones and lines of the whole are in no way obscured by the fine drawing of detail.

The Oceanography of the North Siberian Shelf

H. U. Sverdrup. **The Wind-Drift of the Ice on the North-Siberian Shelf.** 46 pp.; map, diagrs., ills., bibliogr. (The Norwegian North Polar Expedition with the *Maud*, 1918–1925, Scientific Results, Vol. 4, No. 1.) Geofysisk Institutt, Bergen, 1928. 12 x 9 inches.

H. U. Sverdrup. **The Waters on the North-Siberian Shelf.** 131 and 75 pp.; maps, diagrs., bibliogr. (*Ibid.*, Vol. 4, No. 2.) Geofysisk Institutt, 1929. 12 x 9 inches.

These two publications present the detailed features of the oceanography of the continental shelf lying north of Siberia. The first one deals with the drift of the ice in this region. During the two-year period from 1922 to 1924, when the *Maud* was drifting with the ice over the shelf, continuous records of the wind were obtained. These, together with the numerous astronomical observations made for the purpose of determining position, furnish excellent material for a study of the effect of the wind on the drift of the ice. The problem is an interesting one, and its investigation has brought out results of wide application. At the beginning of the present century, when studying the observations on the drift of the ice during his North Polar expedition in the *Fram*, Nansen was struck by the fact that for any given period the drift of the ice was not in the direction of the resultant wind but about 30° to the right of that direction. He suspected that this deviation was due to the deflecting force of the earth's rotation. At his suggestion V. W. Ekman investigated the matter mathematically and arrived at the surprising result that in an unlimited ocean the wind brings about a current that on the surface sets 45° to the right of the wind in the northern hemisphere and 45° to the left in the southern hemisphere.

On the basis of his observations Sverdrup finds that there is no permanent current on the North Siberian shelf, so that the ice drift here is a pure wind drift. As a general result he deduces that in this region a given wind produces a drift with a velocity 1.75 per cent that of the wind, its direction being 33° to the right of the wind. He finds, however, that this relation is subject to an annual variation with a minimum in spring and a maximum in late summer. Thus in spring the ice drift is 1.4 per cent of the velocity of the wind and deviates about 15° from the wind direction, while in the late summer the velocity relation is 2.4 per cent and the angle of deviation about 40°. The explanation of this, from his theoretical discussion, appears to lie in the resistance arising from the drifting ice meeting ice at rest or in a different state of motion. This resistance obviously is greatest in the spring—the end of the cold season—when the ice is tightly packed, and least in late summer when open lanes of water exist.

In "The Waters on the North-Siberian Shelf" Sverdrup considers in detail the characteristics of the waters in this region. The observational data comprise soundings, temperatures, densities, salinities, oxygen content, hydrogen-ion concentration, alkalinity, currents, and ice drift.

These observational data are of more than ordinary importance, not only because they furnish basic information in a still imperfectly known field but also because of their precision. We have here not casual information but precise data, which may be directly correlated with other precise measurements and which permit definite quantitative conclusions. Such precise data are especially valuable for the regions in high latitudes, since the severe conditions under which the observations must be made introduce numerous sources of error that do not arise in more temperate latitudes. For example, the temperature of the upper layers of the water in these regions is, in winter, always close to freezing. Hence when a water bottle is brought into contact with this cold water it becomes immediately covered with ice not only on the outside but, what is more serious, also on the inside. This ice, having a different salinity than the water out of which it is formed, manifestly will introduce an error into the determination of the salinity of the sample of water. To secure samples of water that would accurately represent conditions at any given depth, Sverdrup found it necessary to leave the water bottles at that depth for as long as 30 minutes.

In considering the bathymetric features of the region, Sverdrup finds that the shelf between Taimyr Peninsula and Alaska divides itself naturally into three well differentiated regions, to which he attaches definite names. The sea between Taimyr Peninsula and the New Siberian Islands has the characteristics of a bay, the depth increasing regularly from the shore outward. There is a wide area here along the coast with a depth less than twenty meters, but outside this limit there is a rapid increase in depth. For this region Sverdrup retains the name previously attached to it, namely "Nordenskiöld Sea." Eastward from the New Siberian Islands as far as Wrangel Island the sea is very shallow with a great area having a depth less than 20 meters. The depth of 60 meters is reached only at a distance of about 300 miles from the coast. To this area Sverdrup attaches the name "East Siberian Sea," a name previously used by Schokalsky to include this region and also that eastward as far as Bering Strait. From Wrangel Island eastward to Alaska, however, the larger part of the shelf is covered by water 40 to 60 meters in depth; and for this region Sverdrup proposes the name "Chukotsk Sea," "after the sturdy people, the Chukchee, who inhabit the southern coast of this sea."

The discussion of the oceanographic features of the waters in the Chukotsk and East Siberian Seas is followed by sections dealing with wind currents in shallow water and eddy viscosity, the appearance and growth of the Arctic pack, and the influence of the formation of ice on the composition of sea water. These matters are considered in the light of previous investigations, to which reference is made, so that these sections summarize the latest knowledge in regard to the subjects with which they deal.

H. A. MARMER

A PHYSIOGRAPHIC STUDY IN SOUTHERN CALIFORNIA

CARL SAUER. **Land Forms in the Peninsular Range of California as Developed about Warner's Hot Springs and Mesa Grande.** Maps, ills. *Univ. of California Publs. in Geogr.*, Vol. 3, 1929, No. 4, pp. 199–290.

This paper is a detailed analytical study of the physiography of a part of the California highlands near the Pacific Coast southward from Los Angeles. It contains a regional physiographic map in colors and a series of twenty photographic plates representing a critical selection of features of technical value in the argument.

The region is one of confused relief, as the physiographic map clearly indicates, but order is discerned when interpretation runs hand in hand with observation. A summit peneplain of the primary type is recognized, and the interesting conclusion is reached that it is still in process of development, that is that the relief is even now in process of reduction. The "lower soil-covered flanks are growing at the expense of the upper slopes of discontinuous soil cover, and the dales are enlarging headward as well as transversely." The main themes of the paper are the recognition of these surfaces; their probable modes of origin as repeated in soil profiles, stream gradients, rock structures, and the like; how and why they break down to the topographic levels below them; and the relation of block to block and of basin to upraised or tilted block from place to place through the range. The climate plays a part also in the contrasting features of the landscape, as shown strikingly in the case of the Agua Caliente Mountain unit: "Torrential rains sweep the desert canyons free of accumulated material and accelerate their incision. More and larger material is being taken away from the desert front than is true of the Pacific slopes, and with the advance of the canyon heads and the recession of their walls the desert climate is advancing into the interior of the mountain area and the range of desert degradation is being steadily enlarged." From a study of dissected fans, buried marsh and pond beds, and a comparison of slope profiles it is concluded that the climate was once more arid than today—a result attributable to slight changes in relief, "normal to so unstable a country," that have displaced the limits of arid and humid conditions in at least some of the areas under consideration.

An American View of World Trade Problems

Julius Klein. **Frontiers of Trade.** With a Foreword by Herbert Hoover. xv and 328 pp.; index. The Century Co., New York and London, 1929. $2.50. 7½ x 5½ inches.

The author, Dr. Klein, was the chief helper of Mr. Hoover in making the Department of Commerce what we might call the greatest university of trade in the world. He perhaps had more to do with the growth of our post-war commerce than any other man. The essence of his views and experience is found in these vividly written chapters—"The New International Trade Rivalry," "Trade Barriers," "Raw-Material 'Controls,'" "Our International Cash-Book," "Curious Business: The Queries of our Exporters," "The New Germany," "The Come-back of Britain," and the rest.

The volume is not strictly unified in plan and structure and, indeed, is partly made up of essays previously published. The limits of this short notice cannot be better filled than with some of the kernels of commercial truth, vital to a world that wants peace. There are rivalries, and the merchant and manufacturer must have world-wide contacts. All activity is changing. Machines have driven multitudes out of the factory and off the farm; but automobiles, electricity, motion pictures, *teaching*, and *hairdressing* have taken up the slack and occupied them all.

Employee participation is transforming business. Our growing trade with Latin America and the East does not hurt Europe but pours money into its treasuries. Trade rivalry is mainly a false imagination. The secret of good business among nations, as between individuals, is good will and coöperation. Sound ethics and sound trade go together.

The motion picture (to quote Hoover) is "one of the most powerful bonds among nations." If German buying power is impaired it will cut short all our markets in Europe. The recovery of our relation to that country reveals the fact that more than from all other nations put together, German experts come here to learn. Let any one who does not wish England well see what would happen to us by the shattering of her buying power. England is not hurt by our supplying twenty-two per

cent of Australia's imports. Even our cotton trade with Chile supplements rather than injures British cotton trade there. Such are sample glimpses of the author's keen and modern discussion of trade problems.

ALBERT PERRY BRIGHAM

WATERWAYS OF THE UNITED STATES

E. S. CLOWES. **Shipways to the Sea: Our Inland and Coastal Waterways.** viii and 196 pp.; maps, ills., bibliogr., index. The Williams & Wilkins Co., Baltimore, 1929. $4.50. 9 x 6 inches.

In this small and attractive book there is packed more information, more good sense, and more non-controversial materials about the nation's waterways than can be found probably in any other source of similar space. Briefly, the book presents at the outset the historical background of our waterways and then in turn tells the story of the Mississippi system and its floods, the Great Lakes, the St. Lawrence waterways, Barge Canal outlets from the Lakes, the Atlantic Coastal waterways, and the status of waterways west of the Rockies.

In a chapter on Dreams and Visions the author pays his respects to many waterway schemes of the past. His criterion of a sound waterway policy is tersely stated: "A canal is not merely a ditch; it is a ditch filled with water . . . Nor is a completed canal necessarily a waterway. It must justify itself by performing a service which in all its implications no other transportation service can do as cheaply and as well." Among the "expensive tastes" in canals is cited the Lake Erie to Lake Michigan-Maumee River route and the 14-foot Lakes-to-the-Gulf scheme.

The book is a forceful argument for a national system of waterways so coördinated that it will form a great auxiliary system of transportation to railroads and truck lines. To this systematic plan, the work on all streams today should be in harmony so that the local unit will need as little reconstruction as possible when the larger plan attains fulfillment. The author is sure that waterways will pay for themselves in traffic, but he sees greater returns from them in farm relief by a reduction of cost of grain transport, in equalization of lumber prices, and in better distribution of fuel at lower rates. The success of the Great Lakes waterway supports the author in this hopeful view; but when the history of the Mississippi River traffic is studied one can be pardoned if a little skepticism creeps in. As a traffic highway, the Mississippi River has not been a successful venture; but as a component of a national system, not as a unit in itself, the author insists that it will be necessary and successful.

ROBERT M. BROWN

A WORLD TOUR FOR TRANSPORTATION STUDY

WILHELM TEUBERT. **Die Welt in Querschnitt des Verkehrs.** xvi and 513 pp.; maps, diagrs., ills., bibliogr., index. Kurt Vowinckel, Berlin-Grunewald, 1928. M. 32. 10 x 7 inches.

With characteristic German foresight, the author of this work toured the world to study not only the status of modern transportation but also the factors likely to affect its development on each continent with special reference to the economic part that Germany might play. He works upon the hypothesis that the stage of development in a nation's transportation facilities reflects the people's economic progress. Usually transportation in all its forms is associated with industry and vice versa. Since the South American countries, particularly those of the eastern areas, presented evidence of a probable rapid development in the near future and seemed to offer better opportunities for German industrialists and emigrants than the United States holds forth, the author spent half his time in South America and divided the rest

equally between North America and Asia. Nearly half the text of the book is devoted to the section entitled "The Rôle of Transportation in the Business of South America and the Possibilities of German Participation." There is much material here to stimulate those of an economic turn of mind as well as those interested in colonial development and the problems associated with "peaceful penetration."

One is always attracted by the impressions which foreigners gain of one's own country. Teubert seems to have been fairly overwhelmed by the transportation evolution and present accomplishment in the United States. His observations apparently were more than merely cursory. His detailed account of our larger ports points to careful study on his part. Many an American could profit from a reading of this vivid account of the economic activities in our country.

The volume is well illustrated and has a full index. A bibliography includes much chamber of commerce literature of doubtful value with respect to accuracy, but apparently the author was able to select judiciously such data as he uses in this volume.

EUGENE VAN CLEEF

PLANT ECOLOGY

J. E. WEAVER AND F. C. CLEMENTS. **Plant Ecology.** xx and 520 pp. McGraw-Hill Book Co., Inc., New York, 1929. $5.00. 9 x 5 inches.

In this volume the distinguished authors have presented the philosophy of plants in relation to environment in a style both scientific and charming. But they have done much more than that, they have given a concise discussion of the method of research whereby these relationships have been and are being discovered.

There are eighteen chapters in the book; the first deals with origin, development, and structure of vegetation; and the second with the methods of studying vegetation. From this beginning the reader is carried deftly through the fundamentals of the plant aspects of ecology under the topics of "Units of Vegetation," "Plant Succession," "Aggregation, Migration, and Ecesis," "Competition and Invasion." The relationships of natural vegetation to environment are next dealt with in considerable detail. The discussion of the soil as a factor in plant growth deserves special commendation. It is made effective by full recognition of the recent progress in soil science—a field outside the realms of plant ecology but inseparably connected with it.

Factors of climate, soil moisture, light, temperature, and the plant responses are dealt with at length. The closing chapter gives a concise discussion of the Climax Formations of North America, and here a stand is taken far in advance of what has been presented by earlier writers. That some will hesitate to accept the conclusions of the authors respecting the ultimate climax vegetation formations of the continent is to be expected, but all will find the arguments so given upon bases of fact and scientific logic as to deserve thoughtful consideration.

Geographic relationships are emphasized throughout, and the book is one which geographers will appreciate as a valuable addition to the literature in a field too long neglected.

NELS A. BENGTSON